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THE TECH ENGINEERING NEWS

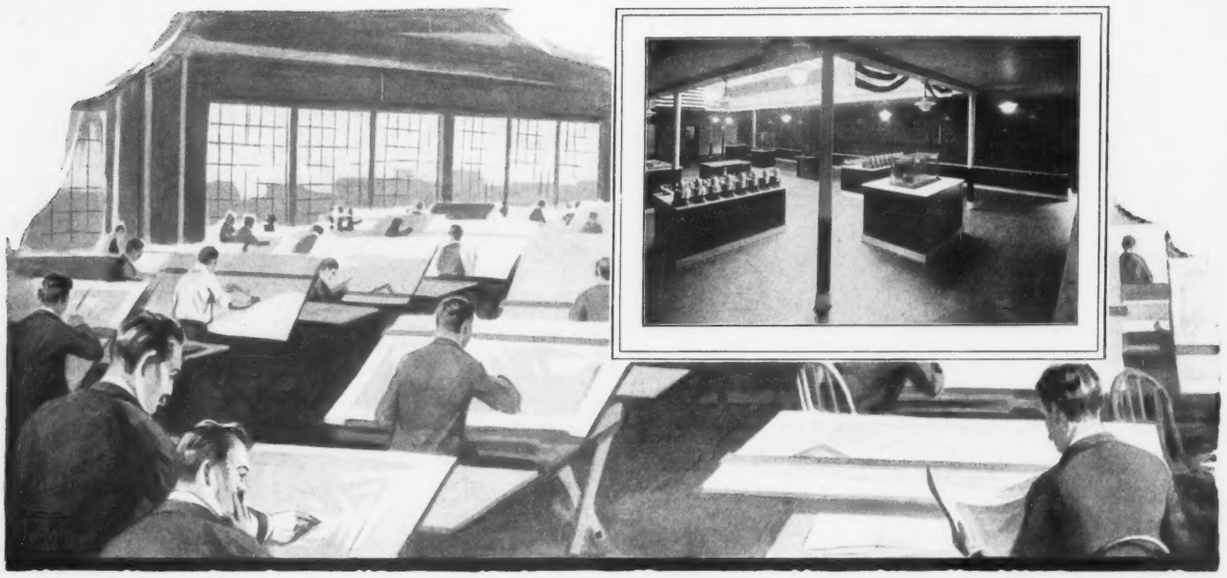
MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

VOL. IV. NO. 8

FEBRUARY, 1924

TRACKS OVER WHICH BUILDING PASSED. SEVEN MILES OF RAILS WERE USED

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS



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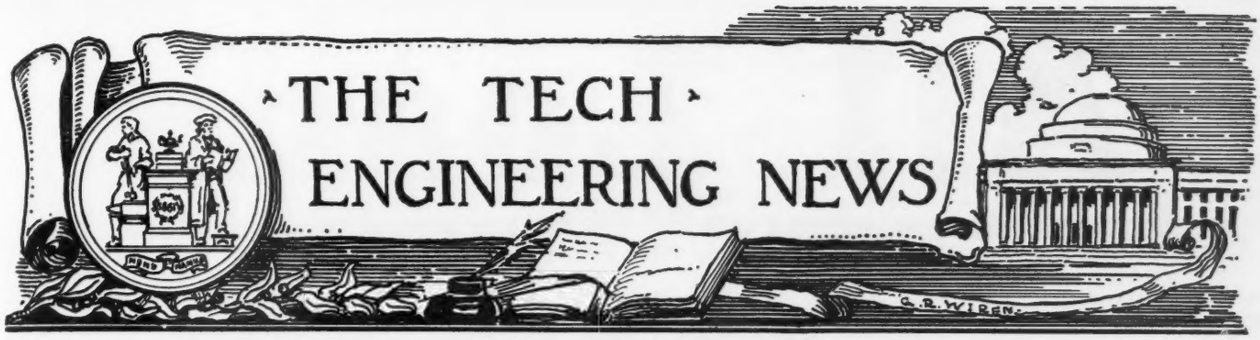

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All Loads

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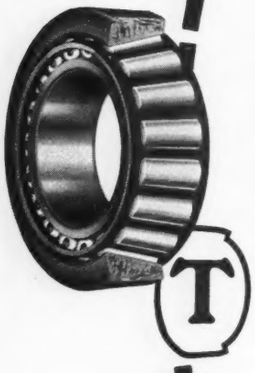

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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PROGRESS IN ARTIFICIAL SILKS

PROF. E. BRONNERT, PH. D., of Strasbourg and Mulhouse, Alsace, France, who is a manufacturer of very large quantities of artificial silk, gave an interesting and instructive address upon the progress made in the artificial silk industry. Professor Bronnert said that the idea of producing practically artificial fibers, which might perhaps some day supplant those of the silkworm, was due to Count Hilaire de Chardonnet, who has been called the father of the artificial silk industry. To him we owe the nitro-cellulose process, on which he published a memoir in 1884. This process was the first to be used on an industrial scale and was prevalent throughout the nineties. The close of the nineteenth century saw the industrial adoption of the cuprammonium process by Bronnert, Fremery and Urban. Following hard upon these two processes are those of the viscose and, more recently, the improved viscose processes.

The use of artificial silk may be said to be as yet in its infancy, and from day to day fresh uses are discovered for its products. They tend to increase as cheaper processes are evolved. The silk as it was originally manufactured, owing to this factor of cost, has been used advantageously only along with other textile fibres, such as cotton, and in these cases the fiber preponderating has not been the artificial silk. It is only now that artificial silk alone is being used in the manufacture of articles on a large scale. The present fashions have been of much use to the industry for it has been possible to use the silk in the manufacture of ties, jumpers, stockings, underclothing, and articles of a similar nature, without the admixture of other fibers.

A new step has been taken in the production of artificial viscose silk. Until now artificial silk, for a variety of reasons, has only been produced of a count varying from eight to ten deniers, while the double thread of the silk worm is of two to three deniers. It has always been a complaint among consumers of artificial silk thread that manufacturers appear to be unable to place a thread of the fineness of natural silk on the market. A French inventor and artificial silk manufacturer has answered this complaint in a most remarkable manner.

Colloidal solutions of cellulose, like viscose, are spun by the well-known process of forcing them through fine apertures. The apertures were required to be smaller in the case of a fine thread and larger in the case of a coarse thread. More concentrated solutions of cellulose were required to obtain stronger threads. Concentrated solutions of cellulose require narrower openings because of their high content of cellulose. However, the difficulty in filtering the solutions in order to prevent a rapid choking, the boring of the apertures, and the increased pressure required, are all causes of an irregular spinning, and operated therefore against a higher concentration. Hitherto an average good spinning of eight deniers has been accomplished, with a solution containing eight per cent of cellulose, and with apertures of 0.1 mm. diameter.

Many were the attempts made to solve this problem of the fine thread. The employment of finer apertures occasioned only more difficulties. An attempt to draw the thread off rapidly as it was produced, and one of feeding less viscose to the nozzles proved quite unsuccessful. Now, however, it has been shown that under certain conditions threads of two or three deniers and less may be spun with the greatest regularity and ease. The same size of apertures may still be used and the same maximum spinning speed of forty-five meters per minute may be continued. The two factors of this important improvement are the feed of viscose to each aperture in relation to a unit of time, and a minimum percentage of acid, different for each count, that is necessary in the spinning bath. Below this minimum, spinning of this count is impossible. It is a well-known fact that a rapid exhaustion of the acid spinning bath takes place in the case of the former eight denier threads, when the flow of the alkaline viscose running through an acid bath has neutralized the acid to a greater or less degree. But until now it has not been known that for each count a special and strictly limited minimum concentration of viscose in conjunction with an appropriate feed, was required, and that it was possible to retain the usual nozzle of 0.1 mm. by using the ordinary viscose as used by ripening the alkaline cellulose first and then the viscose solution itself matured to a certain degree.

In this new process for fine spinning, maintaining the minimum concentration for each count is so important that no lower count can be spun with regularity than that of the particular thread for which the process is adapted. There is a certain relation between the counts of a single thread and the concentration of the acid in the spinning bath, and this has been reduced to a law named by Professor Bronnert the "Square Root Law": "The square roots of the different counts are inversely proportional to the concentration of the acid in the bath." The minimum concentration for eight denier thread is, as already known, 140 grams of monohydrated sulphuric acid per liter. For this new spinning process no change need be made in machinery, the output remains unaltered, and any count may be spun with the apparatus by conforming to the conditions laid down by the Square Root Law.

Brilliancy in the fine counts may be varied at will and without any damage to their strength. To reduce brilliancy and to obtain an opaque thread it is only necessary to lower temperature. By raising the temperature to forty to fifty degrees C. a thread of higher brilliancy is produced. The new viscose has a very soft touch, a much increased covering power, dyes evenly, and when woven does not easily crease.

Methods have been put forward for the recovery of the by-products in the viscose process. In the cuprammonium process a recovery of about ninety

(Continued on page 328)

HISTORY OF THE ARCHITECTURAL DEPARTMENT

By PROFESSOR WILLIAM EMERSON
In charge of the Department of Architecture, Massachusetts Institute of Technology

THE history of the Department must of necessity be a record of the contributions of each successive head to the school's progress. I have therefore endeavored to outline the history from this angle in an attempt to thus give fresh interest to an already much told tale.

The foundations, corner stone, and preliminary sketch of the Department as it now exists may well be credited to Professor William R. Ware. Under his guidance the Department came into existence, and for fifteen years thereafter profited by his broad-minded conception of the possibilities that an architectural education should offer to its students. These early years were fraught with difficulties that to our time, when architectural schools are springing up on all sides, seem almost inconceivable. Remember that this school which came into existence in 1865 was not only the first school of architecture in America but was the first in the Anglo Saxon countries. Professor Ware spent the year immediately after his appointment studying European schools, getting the advice of foreign architects, consulting such men as Waterhouse in England, Viollet-le-Duc and Charles Garnier in France, and, with their help and advice, building that foundation upon which our structure has so safely rested.

Books and casts, drawings and photographs poured in from home and abroad, and with their advent and the coming of Professor Chandler as Professor Ware's assistant in 1869, the corner stone of our fabric may be said to have been safely laid.

From then on the edifice grows slowly towards completion which may be considered to have been achieved with the graduation of the first regular student in 1873. This ancestor of all who have won their degrees in Course IV is a most loyal son of Technology. His class celebrated its fiftieth anniversary last year, and he himself makes at least one visit a year to learn how his much beloved department is progressing. This is Mr. Henry A. Phillips.

Mr. Phillips is typical of those who followed Professor Ware's banner in those early days. It was while he was an undergraduate that Mr. Eugene Létang came to teach design, and even earlier than this, in 1869 to be exact, the Boston Society of Architects began that generous expression of interest in the growing school that it has consistently maintained by offering prizes for good student work.

In 1875, on its decennial, the Department counted thirty-two students of whom only ten were regular applicants for the degree, but in spite of this modest showing, and in spite of woeful lack of material that is the subject of constant comment in the annual reports, Professor Ware speaks of a steady improvement in the quality of the work. That we are justified in saying that Professor Ware was responsible for the preliminary sketch of the Department as we now know it is apparent as we read the following in regard to design quoted from one of his annual reports:

"More practical problems would require for their solution more practical experience than such classes as these can possibly have had, involving for their solution numerous considerations of detail, which it would not do to slight, but which students in the beginning of their studies are not prepared to entertain. Work of this kind, on the other hand, while it taxes their powers to the utmost, both in the execution of the drawings and in the design, does not demand, for its satisfactory performance, any greater resources either of knowledge or skill, than they have at command. Besides, its remoteness from daily use and observation not only stimulates the imagination and fancy, but necessitates the study of the books and of the work of the best masters."

It is interesting to know that in 1876 the student-work of the Department was exhibited in Philadelphia at the Centennial Exhibition, and there attracted much and favorable comment from the American Institute of Architects, in consequence of which our resources were much enriched by gifts of sculpture, measured drawings and photographs, although even so the equipment fell far short of what Professor Ware felt was needed. And then in 1881 the Institute lost this founder of one of its original departments; he went to Columbia, there to continue to build and create, to inspire and to help; but though his inspiriting personality was no longer present, his well-planned legacy of architectural education remained as ever valued evidence of his sound and far-reaching judgment.

Mr. Theodore M. Clark took up Professor Ware's burden, and evidently maintained the standards so well established by his predecessor, for in 1885 we read of the fifty-one students registered being such an increase over previous years as to necessitate more spacious quarters. A little later Mr. Dwight H. Perkins, now of Perkins, Fellows & Hamilton, of Chicago, was engaged as an instructor, and in the same year Mr. C. Howard Walker was named a lecturer, thus beginning a connection with the

THE TECHNOLOGY SERIES

Last year THE TECH ENGINEERING NEWS published a series of articles on the buildings, laboratories and business administration of the New Technology. This series met with such widespread approval among our readers that we are continuing the idea this year. Our new series will be of a slightly different character, dealing with the great personalities and the more human side of the Institute. As our space limits us to only a bare outline of the subject, it is hoped that the new series will serve as an inspiration to further reading along this line. The topics which the series will cover are as follows:

THE FOUNDERS OF THE INSTITUTE ..... *October*
Prof. H. W. Tyler, Head of the Department of Mathematics.

FRANCIS AMASA WALKER ..... *November*
J. P. Munroe, Secretary of the Corporation, M. I. T.

RICHARD COCKBURN MACLAURIN ..... *December*
Harold Eric Kebbon, Architect.

A HISTORY OF THE SOCIETY OF ARTS ..... *January*
Prof. H. M. Goodwin, Department of Physics.

A HISTORY OF THE DEPARTMENT OF ARCHITECTURE..... *February*
Prof. William Emerson, Head of the Department of Architecture.

RELATION OF INSTRUCTOR TO STUDENT AT TECHNOLOGY ..... *March*
Prof. L. M. Passano, Department of Mathematics.

A HISTORY OF THE DEAN'S OFFICE..... *April*
Author to be announced later.

GREAT GATHERINGS AT TECHNOLOGY..... *May*
Author to be announced later.

Institute and the teaching of architecture that he continues at the present time with unabated energy, with growing breadth of experience, and with an accumulating affection from the many generations of students who have been so fortunate as to know him. At the same time came Ross Turner and David A. Gregg — names to conjure with in the field of water colors and pen and ink drawing; and with their coming another milestone was passed, for Professor Clark resigned his responsibilities to Prof. Francis W. Chandler.

No happier event has occurred in the life of the Department than the selection of Professor Chandler to undertake its guidance. This is true both because of his personal qualities and of the broad and varied experience which he brought to the aid of the growing school. As we have seen, he had been acquainted with the infant Department in 1869 under Professor Ware, an acquaintance which followed three years of student work in the firm of Ware & Van Brunt, and two years in the Atelier Daumet in Paris. After leaving the Department his experience was broadened by three years as assistant supervising architect of the Treasury, followed by an active professional career in Boston as the junior partner in the firm of Cabot & Chandler.

The early years of his direction showed an adaptation of the curriculum to good current professional requirements. A broader schedule was outlined for the special students, summer work in architects' offices was advised, and the theory of applied mechanics was made directly applicable to practical problems in steel construction. These changes improved the quality of the students entering the Department and encouraged Professor Chandler to take the next and drastic step which was the final elimination of the "two years partial course." At the same time provision was made for special students under conditions very similar to those existing at present. An indication of the general attitude of the student body is shown at this time by the action of the Class of 1890 in leaving a sum of money on graduation as a token of their interest in the "assured welfare and progress of the Department."

The wisdom of Professor Chandler's various activities in raising the standard of the work in the Department was immediately expressed by an increase in the number of students in spite of the abolition of the two years partial course. Additional pace became a crying need. At this ime the Department was housed in he upper floor of what was known as Engineering B Building, having graduated successively from space in the upper part of Rogers to the second floor of Walker before reaching these existing quarters. Consequently in 1891-92 a fourth move was made — this time to the Henry L. Pierce Building, which most satisfactorily met their needs and was furnished throughout by the generosity of that good friend of the Department, Mr. Arthur Rotch.

At this same period Mr. Letang, who for twenty years — since the early days of Professor Ware's direction — had presided over the teaching in design, was suddenly stricken down by a disease that terminated fatally in November, 1891. His skill in criticism, correction and instruction at the draughting board are spoken of with the highest appreciation, and the difficulty of securing a competent successor confronted Professor Chandler as his heaviest responsibility.

CORRECTION

A mistake was made in the heading of the Series Article, "Richard Cockburn Maclaurin." Mr. Eric Kebbon, the author, has been practicing architecture under his own name for the past two and a half years. He is not connected with Wells Bosworth, as the heading indicated.

As Professor Ware had turned to France to secure his teacher of design in the earliest days of the Department, so now Professor Chandler sought from among the well-trained graduates of the Ecole des Beaux Arts one who might correspondingly meet the needs of the well established school. In Mr. Désiré Despradelle, the Department found a teacher of such training and inspiration as to carry it far forward to the very headship of the group of schools of architecture then existing in this country. Mr. Despradelle brought to his task a store of enthusiasm that swept the students on with him towards the development of the fifth or graduate year in design. This was one of Professor Chandler's special ambitions, and under Professor Despradelle's inspiring influence became a most successful feature. It attracted men of the highest calibre, and gave to these advanced students a highly specialized training that was not then available anywhere else in America.

In successive years at this time we note the appointments of Mr. H. W. Gardner and Mr. W. Felton Brown respectively as instructors in architecture and in drawing, their appointments having been preceded in 1891 by that of Mr. William H. Lawrence as instructor in architecture. At the same time with the strengthening of the teaching staff as indicated above, came valuable additions in books, photographs and prizes, to improve the equipment and to reward the labors of the most deserving students. Mrs. Henry Draper was an indefatigable friend in the former field together with Mr. Arthur Rotch, who also established annual prizes for the best regular and special students.

The activities outside of the regular course from which the students benefited were many and various. These were summer school sessions, held in Chicago in 1893, later in Salem and Quebec; trips to Europe; and an uninterrupted series of successes in the inter-school competitions conducted by the Beaux Arts Society in New York, all of which bear evidence to the far-reaching vision and enterprise of Professor Chandler.

The course in Architectural Engineering, known as Course IV, Option II, was started in 1898 under the direction of Professor William H. Lawrence, and at about the same period an option in Landscape Architecture was offered. Hand in hand with this reaching out into more specialized fields of endeavor went an ever improving standard of work. Student-drawings sent to the 1900 Exposition in Paris received such recognition that a request was received from the French Government for the presentation of a large number of them to the Ecole des Beaux Arts.

An ever increasing number of students of such a quality as to add to the high reputation of the Department, together with a constantly growing demand for the opportunities offered in the fifth or graduate year, may be said to characterize these middle years of Professor Chandler's direction. During these years also the Class of 1904 Prize was created, and a Traveling Fellowship of twelve hundred dollars awarded, while the percentage of college graduates entering the Department steadily increased, and certain Course changes were made, particularly in the language and engineering requirements, that greatly improved the standards of work.

It is of paramount interest to the present direction of the Department to realize that in his annual report of 1908 Professor Chandler urges "the desirability of requiring in the near future five years' attendance in this Department to attain the Bachelors' degree. Beginning fifteen years ago the necessity of a longer school training for our students became evident, and the effort of the Department was directed to that end. The training of our first year might well be accomplished in a preparatory school so far as concerns its direct influence on our professional work. Adding another year simply places the degree where it belongs, and puts us more nearly on a par with the requirements of the

(Continued on page 336)

MOVING A SEVEN STORY BUILDING

By HUGO FILIPPI
Engineer, Wm. H. Brown & Company, Chicago, Ill.

INCIDENT to the vast Terminal Improvement program of the Illinois Central Railroad Company and of special interest to Engineers and to the public generally, the moving of the Dowie Building during the past summer has occupied a unique position in the public eye owing to the location of the building, its size, weight and limited working space in which the work was done.

The Dowie Building, known also at various periods of its life as the Zion building and as the Imperial Hotel, was erected about thirty years ago. The building reached its greatest prominence as the home of the Zionist cult under the leadership of John Alexander Dowie. It was purchased by the Illinois Central Railroad Company in 1907, remodeled and strengthened in 1914, and has since been used for office and record storage purposes.

The building is seven stories in height, 81 feet in width and 131 feet in length. In construction, it may be classified as of the wall-bearing type — that is, wood joists supported by exterior brick walls and interior columns and girders of cast-iron and steel. The north and west facades are faced with cut stone. The old foundation was of rubble supported on wide slabs of stone resting on blue sand, at about elevation minus one. No piling or wood grillage was used.

As a part of its terminal improvement program the Railroad Company was confronted with the problem of either demolishing the building or of moving it to permit the construction of the proposed Roosevelt Road viaduct, which will be undertaken at an early date and will extend eastwardly from Michigan Avenue across the old site of the building and the waylands of the Railroad Company to Grant Park.

Early this spring it became apparent that the question of either moving or demolishing the building should be decided without delay, and estimates covering the probable cost were prepared. The feasibility of moving such a large building was naturally very carefully considered, but as there appeared to be no physical or structural reasons precluding such a step it was decided that the building could be moved safely and without injury to the structure or to adjacent property.

The character of the soil on which the building would rest in its new location was next determined. Nine test holes were put down and a bed of very hard blue clay was found at elevation minus 1.5. An examination of these borings indicated that no piling would be necessary and the new foundations were accordingly designed with spread footings.

The unit soil pressure used in the design of the foundation was 3,000 pounds per square foot, as provided for in the City Building Code for the character of sub-soil encountered. The proportion of all footings was determined by considering the superimposed dead load combined with fifty per cent of the live load of all floors

BUILDING SPOTTED ON NEW FOUNDATION SHOWING OLD BASEMENT

and the unit live load taken was one hundred pounds per square foot for the first floor and fifty pounds per square foot for all other floors.

The new concrete foundation is essentially rectangular in plan. In addition to the footings supporting the enclosing walls of the building, one set of parallel walls was constructed for the east and west hallway and one set of parallel walls for the north and south hallway. In addition foundations were also built for the brick vault which extends to the third floor. Isolated footings for fourteen interior columns were built, ranging in size from five feet nine inches by five feet nine inches to six feet nine inches by six feet nine inches. In general, all footings are four and one-half feet thick and are carried down to elevation minus 1.5, there being but few exceptions where the footings are carried lower. The top of the concrete floor was placed at elevation plus 3.5, except in the boiler room, where it was carried down to elevation plus 1.0. All footings under exterior walls are nine feet wide and the footings under interior walls are either seven feet or seven feet six inches wide. 1:2:4 concrete was used throughout. The foundation walls were finished off at elevation plus 3.82.

Notwithstanding the close proximity of the foundation walls to City Datum, no waterproofing of any kind was used. The imperviousness of the walls and floors was proven in several instances during the heavy rains of the past summer, when the foundation was completely surrounded by water, and it is very gratifying to report that not a single leak of any character developed, thus proving the contention of many authorities that a dense, well-mixed concrete, carefully placed, is the best as well as the most economical method of waterproofing.

All footings are reinforced transversely, and are sufficient depth to carry shear without stirrups, except in the case of three large beams which span wide openings. These beams are heavily reinforced with the full complement of longitudinal bars, bent bars and stirrups.

The concreting plant was simple in character and economical in operation. The governing idea in the design of this plant was the saving of labor. A planked roadway was constructed from Indiana Avenue which enabled all material trucks to conveniently reach the hopper, and the roadway was ramped up to the top of the hopper, the deck of which was built sufficiently heavy to carry the loaded trucks, thus permitting the trucks to stand directly on the hopper and to dump all sand and stone through open traps into the bins without the use of any manual labor.

Only two men were required to handle the mixer, one man handling cement and water and the other wheeling sand and stone. Through the use of the undercut gates it required about two seconds to fill a wheelbarrow and as the wheel averaged only five feet, it was possible for these two men to keep the mixer going continuously. Two one-bag mixers were mounted on the side platforms of the hopper and the concrete was wheeled from the mixer to the forms in wheelbarrows and two-wheel dump buggies. The sand bin had a capacity of twenty cubic yards and the stone bin forty cubic yards. In addition, material was stocked on top of the bins to create an additional reserve. This plant was very economical in operation and assisted materially in the constant

production of concrete of uniform quality.

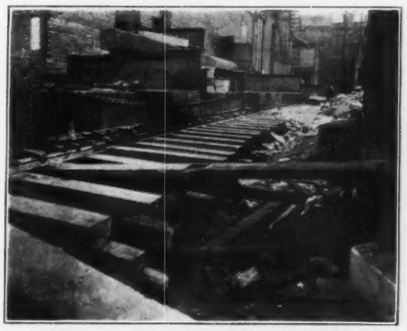
Before any needle beams were placed a diagram was prepared showing the probable spread of live and dead load through the walls. In making such a diagram, the location, spacing and size of windows and other openings is of paramount importance. It was found that a maximum total load of about thirteen tons per linear foot of wall should be provided for and beams ranging from fifteen inches to twenty-four inches in depth, placed in pairs, were used. In underpinning any building the question of deflection rather than of moment is of prime importance and special care should be exercised to guard against excessive beam deflection, which might result in unsightly cracks in the building walls.

The first step in underpinning was the digging of open cribbing pits. These pits were carried down to the hard blue clay as a safeguard against settlement. Holes were then cut through the brick wall, one at a time, with a pneumatic drill and the needle beams were placed on the cribs and jacked up against the brickwork until the needles carried most of the load, the intervening brick piers carrying the balance. This general scheme was used for the south and east walls only, as will be explained later. The cribbing pits were placed sufficiently distant from the new concrete foundation to permit this construction. After the concrete walls had set up sufficiently, the load on the needle beams was transferred from the outside cribs to the top of the concrete wall and there carried until the general cribbing for the moving proper had been placed. This arrangement was necessary in order to provide a free working area within the foundation walls for pouring the floor and building the general cribbing.

Because of its proximity to lake level it was out of question to place any cribbing directly on the soil. To overcome this condition it was decided at the outset to increase the thickness of the concrete floor to about eight inches, and to build all cribbing on this floor. This scheme proved practical and overcame the wretched muddy condition which would have resulted from the heavy rains of the past summer if the cribbing had been placed on the ground and the concrete floor constructed after the building had been moved, as is usually the case.

The north and west walls of the building below the second floor level are supported by cast-iron columns. Here the problem was vastly different and it was decided to cut off these columns below the first floor level and to support each column on two "I" beams. The columns were cut off in two steps to a smooth, square bearing with an acetylene torch. The first step consisted of cutting out one-half of the columns and inserting and jacking up an "I" beam. After this had been done the remaining half of the column was cut away and the second "I" beam was driven into place and jacked up to take its share of the load. In the case of the stone columns, this procedure was not possible and the stone was cut away a little at a time and the load taken up by rails wedged tightly against the stone. The interior cast-iron columns were handled in the same general manner as the exterior columns previously described.

In general, longitudinal timbers were placed adjacent to all north and south walls; 20″ x 20″ x 90″ timbers were placed adjacent to the west and east walls. Incidentally, these timbers



JUST ONE OUT OF THIRTY-SIX TIMBERS
THIS IS 20 BY 20 INCHES BY 90 FEET

are said to be the largest ever hauled through the streets of Chicago. Other timbers for this purpose ranged in size from 12″ x 12″ to 18″ x 18″.

In all, twenty-three tracks were used for moving the building. These tracks consisted of four or more rails each, and extended completely under the building. Each track supported one line of needles or timbers.

In loading a building ready for the rollers, it is first necessary to place jacks under each line of needle beams or timbers. The shoe timbers, roller plates and rails are then placed, after which rollers are set in position, the jacks removed and the load transferred from the jacks to the rollers. On this work the shoe timbers were 4″ x 12″, the roller plates 12″ x ⅜″, and the rollers $2\frac{7}{16}$″ diameter cold-rolled shafting about three feet long.

In order to guard against any spread of the building, overlapping lines of 8″ x 12″ cap timbers, running east and west, were placed under all needle beams and timbers. In addition, a number of tie bars running north and south were used to connect the "I" beam needles located on the same track. In this way distortion of building dimensions was prevented.

In order to properly shore up the building preparatory to moving, parallel lines of cribbing 4 feet wide and about six feet on centers, resting directly on the cement floor, were placed under the building. In this way the total load of the building was carried on fully 75% of the building area. This resulted in a unit soil pressure of only ¾ of a ton per square foot and produced no evident settlement. The general cribbing, placed within the foundation walls in the new location, was of even greater extent, owing to the omission of certain interior walls. In addition to the general cribbing within the building wall area, a line of cribbing 10 feet wide was placed adjacent to the east, west and south walls. The bottom layer of all cribbing was laid solid. In general, the cribbing built on the old site was of 6″ x 6″ and 8″ x 12″ material, and the material used on the new site was 6″ x 8″ and 7″ x 16″. An allowance of about one inch was made in the cribbing for settlement. From the foregoing it will be seen that two complete sets of cribbing were used. This arrangement saved at least two weeks in the time required for moving and avoided the necessity of moving forward an enormous amount of timber. In all, over 600,000 feet of lumber were used for cribbing purposes.

The general arrangement of walls and columns of a building dictates the number of tracks. In this instance 23 tracks were used and were placed in such a manner as to give the most uniform load distribution possible within practical limitations. In general, these tracks were placed from 5 to 8 feet apart, and consisted of four or more lines of 65 lbs. to 75 lbs. standard railroad track rails in lengths varying from about 10 feet to 30 feet. Before moving operations were commenced the top of all rails and cribbing was carefully leveled as a precaution against settlement and to insure a smooth-riding track.

For the purpose of actually moving the building over 2000 steel rollers, spaced about 12″ on centers, were used. Observations during moving indicated an average bearing area on the rail heads about one-half inch wide and probably caused an average bearing of about 4000 lbs. per linear inch on the rollers. Under these favorable conditions no cutting of the rollers occurred.

Four capstans, each operated by two horses, were used as the motive power for moving the building. From each capstan a lead line of three-quarters-inch wire cable was carried down to and through a series of 25 blocks, twelve of which were movable

(*Continued on page 340*)

ENGINEERING FEATURES OF THE MOFFAT TUNNEL

By D. W. BRUNTON*
Chairman of the Board of Consulting Engineers to the Moffat Tunnel Commission, Denver, Colo.

THE construction of railroads across the state of Colorado from east to west is extremely difficult, because Colorado is not only the highest state of the Union, but the Rocky Mountains, which cross the State from north to south, are higher, wider and more continuous in Colorado than in any other portion of the United States.

There are more square miles of territory in Colorado above 10,000 feet altitude and more peaks above 14,000 feet than in all of the other states in the Union put together. In fact, there are so many peaks above 14,000 feet elevation that seventeen of them are still unnamed.

The Argonauts of '49, in their wild rush to the gold fields of California, crossed the continent with ox teams, and to find fresh pasturage for their animals they were continually seeking out new routes, consequently the Rocky Mountain range was thoroughly combed out for low passes.

Years ago when railroad construction began, two favorite emigrant lines to the Far West were found to be most suitable for railroad construction, namely, the Union Pacific line through Wyoming and the Santa Fe line through New Mexico and Arizona. In other words, the two great transcontinental railway lines veered away and passed Colorado to the north and to the south. The highest point on the Union Pacific is at Sherman Hill, Wyoming, where the railroad reaches an elevation of 8,013 feet. The Continental Divide, however, is at Creston, 172 miles further west, where the railroad crosses the ridge that separates the waters which flow into the Gulf of Mexico from those which flow into the Pacific, at an elevation of 7,107 feet; or, in other words, the Continental Divide is 906 feet lower than Sherman Hill.

The Santa Fe comes directly west from Kansas City, but when it strikes La Junta, Col., it sheers off to the south, crossing Raton Pass in New Mexico at an elevation of 7,608 feet, and the Continental Divide at Glorietta Pass at an elevation of 7,431 feet.

The Denver & Rio Grande Western runs across Colorado in its route from Denver to Salt Lake, but to accomplish this it has to zigzag about so much that to reach the western boundary of the state at the Utah line, a distance of 220 miles in an airline from Denver, its length is 484 miles; and to reach Tennessee Pass, where it crosses the Continental Divide at an elevation of 10,240 feet, 74 miles in an airline from Denver, trains have to travel 281 miles.

When the Moffat Tunnel is completed, the Denver & Rio Grande Western Railway, by building a 42-mile line on a water grade up the valley of the Colorado from Dotsero to Orestod on the Denver & Salt Lake Railway, would shorten their line 174 miles, eliminate Tennessee Pass and the canons of the Arkansas and the Eagle.

The necessity of direct route across Colorado from east and west, thus giving a short line to Salt Lake City and the Pacific Coast, was early recognized, but it remained for the late David H. Moffat to put a feasible plan into execution. He was extremely fortunate in securing for his chief engineer Mr. H. A. Sumner, who, knowing that there were no reasonably low passes in the state and none if anything like a direct line between Denver and Salt Lake City, made a careful survey along both sides of the range, at an elevation of about 9,000 feet, to locate points that would be topographically accessible and at the same time give the shortest distance through the range at this elevation. This location was found near the base of James Peak.

Up to an elevation of 9,000 feet, climatic conditions in this state are usually excellent for railroad operation, but above that elevation the snow remains perfectly dry during the winter and drifts so freely that it is extremely difficult to keep railway tracks open.

The eastern portal of the Moffat Tunnel, on which construction has now commenced, is at a point on the South Fork of Boulder Creek, about four miles above Tolland and 37 miles in an airline from the Union Depot in Denver. The western end of the tunnel is located on the right bank of the Frazer River, a short distance above Idlewild.

Both the South Fork of the Boulder and Frazer follow old glacial channels and afford wonderful examples of the erosive work of the immense ice sheet, which, at no distant date geologically, flowed down the sides of the Continental Divide. On the South Boulder the stream apparently follows quite closely the bed of the old glacier, but the central glacier, which formed the Frazer Valley, had so many tributaries that lateral and medial moraines have influenced the course of the river to such an extent that the exact channel of the old central glacier cannot now be definitely located.

To ascertain whether the rock conditions were favorable for tunnel driving, the State Geologist, Professor George, made a detailed study of the rocks exposed along the line of the tunnel and for a considerable distance north and south of it. He describes

*Note: This is an abstract of an address given by Mr. Brunton at a meeting of the Colorado Scientific Society on October 6, 1923.

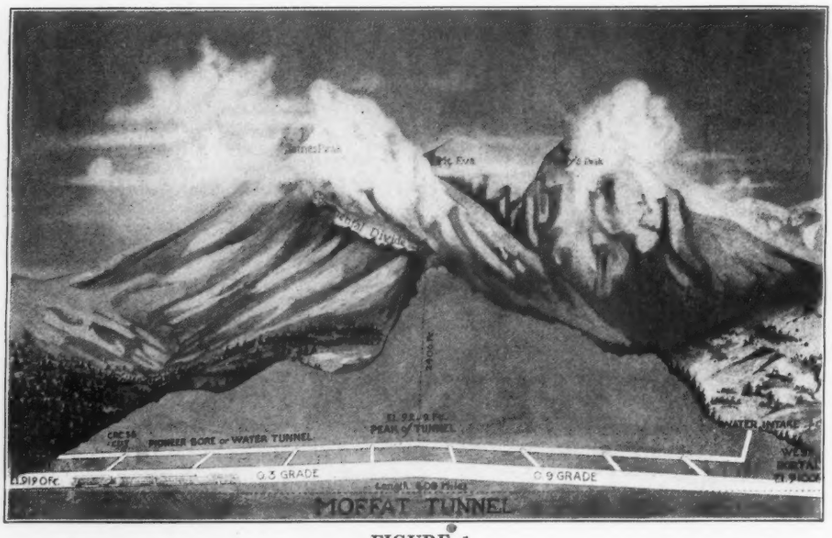


FIGURE 1
Vertical section through tunnel, showing difference in elevation between East and West Portals and water intake incline

these rocks in his report as a complex of gneiss, granite and schist, and as a result of his study came to the conclusion that there are no structural features evident that will interfere with tunnel construction. There are a number of lakes on the side of the mountain almost immediately over the tunnel, and while soundings have not yet been taken in them, there is every reason to believe that they are simply glacial scoops and will not in any way affect the rock underneath or the amount of water in the tunnel, which will pass 1,000 feet below them.

The west portal of the tunnel, as now located, starts near a ridge of rock, but as the ground rises very slowly toward the east, a number of test pits were sunk to test the depth of the morainic material on the somewhat flat ground between Frazer River and Buck Creek. The influx of water

FIGURE 2
Vertical section through Railway and Pioneer Tunnels
Position of crosscuts shown by dotted lines

prevented the sinking of some of these pits to bed rock, but enough information was obtained to show that it is very improbable that the old glacial channel behind this ridge is deep enough to reach the roof of the tunnel.

At the east portal, solid rock in place is in plain sight for thousands of feet, so that there will be no reason for wasting time drilling test holes, and work on the approach cuts is now under way.

On the line of the Moffat Railway, the United States Geological Surveys only extend a short distance west of Tolland, but as the main range for a considerable distance does not vary much in composition, the rocks exposed at that point and to the north and south, which have been carefully studied by the survey, show that the range is principally composed of the following rocks in the order named: Quartz-biotite schist, hornblende schist, gray foliated gneiss and light to dark gray granite, with some intrusive dikes of monzonite porphyry. The mining engineer would roughly class the rocks in the main range as metamorphic granite with some granite intrusions. In some places the changes in the original sedimentary rocks, caused by heat and pressure, have completely destroyed all traces of sedimentation, while in others the old bedding planes can readily be distinguished.

The present terminus of the Denver & Salt Lake Railway is at Craig, 255 miles from Denver, but the completion of the Moffat Tunnel will reduce this distance 23⅓ miles and eliminate 27.6 miles of 4% grade over the mountain. The highest station on the railway is Corona, on the summit of the Divide, an elevation of 11,660 feet, and the highest point on the line when the tunnel is completed will be the apex in the center of the tunnel, an elevation of 9,249 feet, thus affording a reduction in vertical rise of 2,411 feet.

The total distance from portal to portal is 32,150 feet, or 6.09 miles, which will make it the longest railway tunnel in North America; but this length is exceeded by five railway tunnels in Europe, one of them, the Simplon, being double the length of the Moffat Tunnel.

The railway tunnel will be United States standard size, 16 feet wide by 24 feet high, to the intrados of its semicircular roof.

The water tunnel will be approximately 8 feet high by 8 feet wide, and the center lines of the two tunnels will be 75 feet apart.

While these tunnels, when completed, will be separate and distinct from each other, they will be driven simultaneously and advantage will be taken of their proximity in many ways to increase the rate of speed in driving, improve the ventilation and increase the comfort of the workmen.

Opposite the tunnel portals, the valley of the South Boulder is 145 feet higher than the Frazer River Valley (see Fig. 1), and to reduce the fill on the approach to the west end of the tunnel, this portal is located 113 feet lower than the east portal. To equalize this difference in elevation, the west end of the tunnel rises on a grade of nine-tenths of one per cent, while the eastern half has a grade of only three-tenths of one per cent, the elevation of the eastern portal being 9,205 feet and of the western portal 9,092 feet.

A question often asked is, "How can the pioneer tunnel be utilized as a water conduit to bring water from the Frazer River to Denver when the eastern portal is 113 feet higher than the west?" A glance at Fig. 1 will show how this is accomplished.

When the pioneer and railway tunnels are completed, all of the crosscuts between them will be bulkheaded close to the side of the pioneer, and the inner ends of the crosscuts will then become storage rooms for track tools and supplies as well as places of refuge from passing trains for the repair gangs.

The dotted lines show the prolongation of the grade in the eastern half of the pioneer tunnel to the surface on the western slope. From this point an incline will be driven to intersect the pioneer tunnel, the outer end of which will then be bulkheaded. When this is done, the incline and the pioneer tunnel together will form an inverted siphon which will have the same hydraulic grade line as if the eastern half of the pioneer tunnel had been continued through the mountain to the western slope on a grade of three-tenths of one per cent.

In the pioneer tunnel system of driving, which the contractors will employ, the construction of the water tunnel will not increase the cost of the undertaking but, on the contrary, will probably lessen it.

The use of a pioneer or outside heading in tunnel driving is an old, well-established device, which has been successfully employed in the 12-mile Simplon Tunnel in the Swiss Alps and the 5-mile Rogers Pass Tunnel in British Columbia.

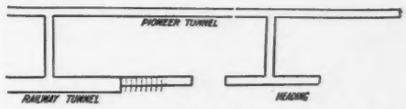


FIGURE 3
Plan of Railway and Pioneer Tunnels showing relative positions of crosscuts and heading

Generally speaking, small size tunnels are driven full size at a single operation; medium sized tunnels, where the roof is too high to be reached from the floor, are driven by what is known as the "bench method;" while the largest tunnels are driven by enlargement from a top, center, side or bottom heading, the position of the heading being determined by the character of the rock and amount of water encountered.

Recently, however, owing to the great improvement in rock drills and explosives, there is a tendency to drive larger tunnels by both the "single heading" and "bench methods." The 18-mile Shandaken Tunnel, which is now being completed as an addition to the New York water supply system and is 10 feet 3 inches wide and 11 feet 6 inches high, has been driven full size at one operation. The Southern California Power Company, in their 6-mile Cascado Tunnel, which is 20 feet wide and 20 feet high, is driving it with the use of a single bench. This necessitates drilling holes 20 to 22 feet in depth and has been so successful that they are now making from 420 to 470 feet a month in each heading.

The great height of the Moffat Tunnel, as compared with its width, does not lend itself to this system of tunneling, in addition to which the rapid growth of Denver will at a very early date require an additional water supply, which can most conveniently be obtained from the Frazer River on

(*Continued on page 330*)

THE ADVANTAGES OF AN ENGINEERING KNOWLEDGE TO THE CITY MANAGER

By R. W. RIGSBY, '19
City Manager, Durham, North Carolina

ENGINEERING knowledge is undeniably an advantage to the city manager but it is not a necessity as has been proven by several notable successes in the field of administration. An analysis of this profession reveals some fundamentals that all administrative positions reveal and that is that success is not dependent upon any special or technical knowledge primarily but rather upon the ability to visualize and harmonize the many problems and conditions that are encountered. Such special knowledge as may be possessed is merely that much advantage, provided that special knowledge does not make the administrative officer partial to one or two phases of the position.

There are managers in the field to-day who are particularly active along certain phases of city manager work whereas other phases are not given the same prominence. That condition is perfectly natural and is to be expected where training for the position has not included a true perspective of the various problems of municipal administration which will show their relative values. It is true that these problems vary some with each city but in the main there is a great need for first getting into the minds of managers that general perspective from which variations may be made to suit the local conditions.

No one would expect a director of public safety to assume the duties of a city manager without leaning considerably toward perfecting the operation of police and allied functions. Plenty of vision may be employed along lines of this nature while other functions may lag behind. The same may be said of an auditor or welfare expert or any other person who has had his energies directed along one phase of municipal work and then is placed in the position of city manager. It is fair to say that the engineer finds himself in a rather more favored position because the very nature of his work in a city gives him a more general knowledge of the various problems ordinarily encountered. The engineer in most any town is a very essential employee and the result is that when a town changes to the city-manager form of government he becomes at once a very likely candidate for the position. This largely accounts for the fact that the majority of city managers to-day are engineers and the engineering profession will probably continue to be a recruiting field for city managers.

The training that an engineer receives is such as will ordinarily be helpful in a great many municipal problems which involve improvement work, city planning, street maintenance, sanitation and similar lines of municipal work, all of which require analysis and vision. A new problem, however, is met from the operative side which consists of harmonizing the various departments in their contacts with each other, in order that the proper care may be taken of the service for which the departments were created. This capacity comes from training and experience and the ability to analyze. When, however, the city manager finds himself in a position of sufficient size to take all his time in administrative duties, or even the greater part of his time, he should erase from his mind all those special interests that might absorb so much of his energies as to make him a lopsided manager.

Of course it is understood that the manager should consider himself as a convenience whereby the council carries out the policies they express and, in turn, they are supposed to express the policies which meet the community's needs. The manager, however, who will be considered a success will be one who has the ability to recommend to the council from his greater experience and knowledge of needs as foreshadowed by a more comprehensive view of municipal life and trends. He will be expected to give these policies the correct relation to the whole municipal service and growth and hold in proper bounds by well stated recommendations those tendencies which cities oftentimes take of going to extremes along certain endeavors and neglecting entirely other important features of municipal service and growth.

One thing that the technical expert must get clearly in mind on entering the field of municipal administration is the distinction between science and art. The engineer deals largely with scientific matters but when he enters the field of city management he deals more with human nature and this requires artistry of the highest quality, for human nature refuses to be cast in molds that are reducible to scientific formulæ. Regardless of his ability along the lines of engineering, the correctness of his street lines, the perfection of his pavements, his plans for the future and his mechanical analysis in all those other matters which require the hand and brain of an engineer some place in its makeup, as an administrative success, the whole structure crumbles unless the hand and brain that guides it all can and does humanize the work throughout.

The Records We Hold. The United States to-day holds thirty-five out of forty-two aviation records of the world: actually she only holds thirty-three, but with the records made at Cowes and Mitchell field, which will doubtless be homologated, she gains two more, making the thirty-five. Of these the Navy holds twenty-three and the Army twelve.

The remaining seven records are shared as follows: France 3, England 2, and Italy and Spain 1 each.

— *Aviation.*

The Automotive Industry. Automobile production for 1923 will nearly, or quite, reach 4,000,000 vehicles, exceeding by about fifty per cent the output in 1922. The rate of production in the last quarter, when a seasonal decline is regularly expected, has been maintained surprisingly well.

The year's extraordinary record, it now appears, was due in part to deferred demand, the magnitude of which was not fully appreciated at the outset. The increasing popularity of closed cars and a growing all-year use of automobiles have been important factors in the recent demand for new cars. In 1919 less than ten per cent of the passenger car production represented closed models. In 1922 the proportion of closed cars had increased to twenty-seven per cent.

The export trade in automobiles, although small in comparison with the domestic distribution, has increased greatly. In the first ten months of this year, domestic exports of automobiles and chassis numbered 126,132, almost exactly double the number exported in the corresponding period last year.—*Guaranty Survey.*

FUEL ECONOMY

By J. H. KESSLER
Automatic Fuel Saving Company, Philadelphia, Pa.

EVERYWHERE we go—whether in the home — among industries — in the super power station — we hear the same thing — "save fuel"— get more out of a pound of coal than we are now getting — increase efficiency!

There are many devices on the market which purport to save coal, to burn it more efficiently in small house-heating plants or the largest industrial boiler. Some are good, and others not so good. Many feasible plans are offered to the industrial plants for better utilizing steam *after* it has been generated by burning that pound of coal, which, of course, makes coal go farther, and indirectly results in a coal saving. Yet, generally speaking, an industrial engineer when speaking of fuel economy, refers more to the actual saving to be accomplished in the furnace itself — the fundamentals concerning the actual ignition and burning of the coal mass. In other words, he refers specifically to the draft conditions, which for a given boiler load supply the proper amount of air to the coal bed, no matter what B. T. U. content the coal itself may have, nor how thick the fire bed, nor how dirty the fire may be — that is, the ash content.

We all know that most efficient conditions are obtained by carrying CO_2 as high as possible without showing more than a trace of CO. Going much higher or lower means a large fuel loss. It is right here that many steam power plants could effect a saving of from four to twenty-five percent of the yearly fuel bill. It is also important to keep the total amount of flue gas per pound of coal at a minimum; that is, to use as little excess air as possible without getting imperfect combustion, indicated by the presence of CO.

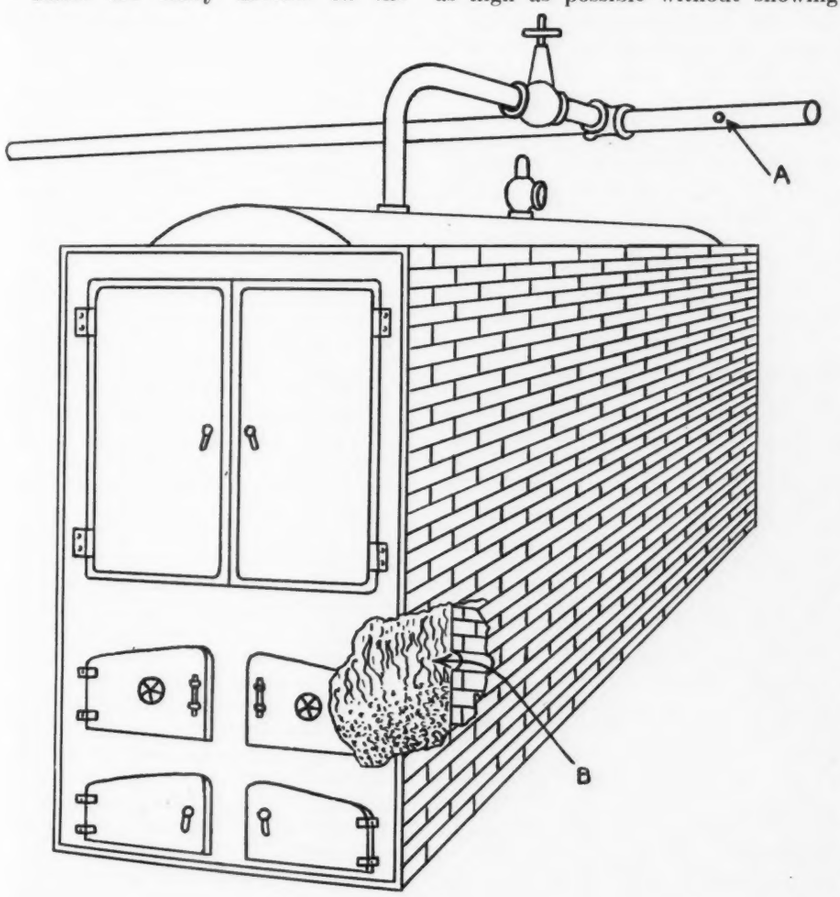


FIGURE 2

While we are agreed on these points, we likewise realize that in the average industrial power plant the fireman operates his boilers mostly by guesswork. He watches the steam gauge. Of a sudden the pressure drops, due to a sudden call for steam. Bang! Friend fireman opens his stack damper, opens up the ash pit doors or starts the forced draft blast, as the case may be. Then the steam demand drops. But the boiler is now getting under full headway. The steam pressure gauge crosses the working pressure point, and off goes the safety valve! Then, like an acrobat, friend fireman proceeds to close down all the dampers, hoping meanwhile that another sudden demand for steam doesn't catch him at it!

During all that time the fire is trying to do its best. The depth of firebed may have been increased when the demand for steam came. With decreased demand it is too thick, or it may be full of ash, thereby preventing enough air getting to the centre of the mass to create perfect combustion. Or many things may be wrong. If the average fire could speak, how it would beg for air at one moment and yell against excess in the next breath! But what can you expect? The fireman is operating solely by guesswork. He is doing all within his power. And look at how much coal has been burned for naught!

Guesswork! That says it! And yet how many plants fit in with the above operating description? Literally thousands.

So before we *begin* to discuss any other means of economy in fuel, is not the sensible move first toward the elimination of the human element in the operation of the boiler plant the riddance of guesswork in meeting the varying steam conditions? Surely it is. And it can be accomplished by placing an "automatic fireman," in other words a simple mechanism upon

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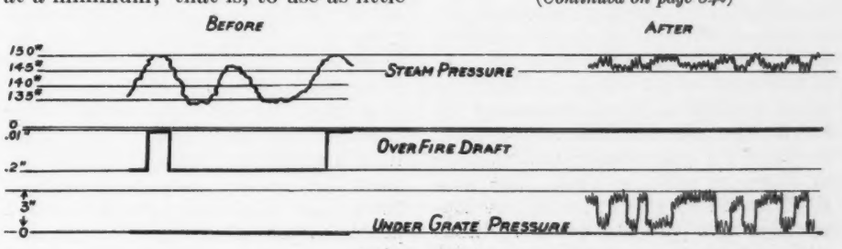


FIGURE 1

THE DESIGNER OF ELECTRICAL APPARATUS

By J. M. HIPPLE
Mechanical Engineer, Westinghouse Electric and Manufacturing Co.

THERE are today in our American colleges many embryo engineers who have through inherited instincts, early training, or otherwise, a bent toward design work. This is by no means true of all engineering students, therefore it is important that each man analyze himself to determine if he has these characteristics, for the man who is so endowed will achieve his greatest success by making design work his life's vocation.

It is a broad statement to say that all electrical achievements, and the growth of the electrical industry are based on the work of the designer, but this is nevertheless true. Consider what the electrical industry would be today if the only electrical apparatus available were based on the designs of thirty years ago. The designer has continuously led the way since the early days, creating new apparatus, larger generating, transforming, and switching units, larger and more economical utilization apparatus. Any young man whose conception of the designer is that of a drudge working over a drawing board day after day has failed to get a true grasp of the importance of the problems that face the designer — of the varied activities required of him in solving these problems.

To get a viewpoint on this problem, let us consider a motor, which is a typical piece of electrical apparatus. It requires only casual consideration to indicate that there are at least three important design factors:

(1) Adequate electrical performance.

(2) Adequate mechanical performance.

(3) Adequate insulation.

All of these requirements must be met if the motor is to be a success. This indicates at once that this design field is not limited purely to electrical designers. There is, in fact, here a very broad field for mechanical designers of electrical apparatus.

Another field for specialization is in connection with insulation and processes. The quality and workmanship of the winding and insulation of a piece of electrical apparatus is of vital importance throughout the life of the apparatus. Were unrestricted space available, the problem might not be so great, but insulation space must be paid for in reduced performance or increased cost, or both. The possibilities are very great for the development of new processes, new methods and new materials. The man with a taste for research in physics, and chemistry, and who is trained in the regular electrical engineering course, is usually well fitted for success in this work. Also, the electro-chemical courses given in some colleges afford excellent training.

How may a young man recognize his talent in design? One of the most easily recognized indications of inherent aptitude for design work is a liking for construction. This is often exhibited at an early age when a child will show considerable ingenuity and spend noticeable time in building a toy only to discard it immediately and start work on something else. Two other characteristics commonly noted in successful designers are curiosity or inquisitiveness, the desire to know the reason why; and persistence, the desire to carry through to a finish, to overcome all obstacles. Another indicative trait is the possession of a mathematical sense, not meaning great facility in the use of involved mathematics, but a working knowledge of the practical application of mathematics. Other desirable characteristics in common with other phases of engineering work are common sense, imagination, and ability to observe and to analyze.

Such a man is essentially a creator. In the order named, he conceives, plans, constructs, exploits. The newly graduated engineer, potentially endowed though he may be with all the desirable qualifications herein enumerated, is not yet a designer. Nothing will do more to develop the designer than experience and this experience must carry its share of responsibility. Almost anyone would make a fair sailor in calm seas, but when the storms come with their varying conditions the resourcefulness of the navigator is then truly tested. So it is with the designer, passing through one storm qualifies him to deal better with the next one, even though it is likely to be a gale from a different quarter.

Some of the men in school today will be the designers of tomorrow. After viewing the progress of recent years in design, someone may be tempted to ask if we are going to need designers tomorrow; if the larger problems have not all been solved. The answer, based on a knowledge coming from an intimate contact with design work for many years past, is that there are new and greater design problems presented each year. Some of the reasons back of the design problems now facing us are the following:

(a) The growth of centers of the population, with the consequent need for concentration of power in the cities. This requires the construction of gigantic generating units and distributing stations, with new problems in switching, control and protection of circuits.

(b) The inevitable growth in transportation requirements for the country which requirements double about every twenty years. Electrification of the railroads — already started — is imminent, and will involve unprecedented construction and equipment.

(c) The growing demand for greater protection of the worker in industry: This takes the form of shorter working hours which can be successfully put into operation only by the introduction of labor saving machinery, and requires that motors be designed to protect workers from accidental injury and that automatic control be installed to protect against accidents due to acts of carelessness or ignorance.

(d) The growing percentage of power load in central stations is emphasizing the low power factor on such systems and is calling for the design of higher power factor utilization apparatus and of power factor correction apparatus.

(e) The aftermath of the world war has brought many nations to the verge of bankruptcy and foreshadows an era of keen competition for world markets. This emphasizes the necessity for designs that can be economically built.

(f) In all of the foregoing cases and many others, including the main generating, transforming, and utilization units, there must be supplied switching, control, protective and metering equipment, the requirements for which are constantly changing.

An attempt has been made to give some conception of design as a vocation. Although it may appear to many from the outside that this conception of design as a vocation presents a rather prosaic picture, yet from the inside — to the true design engineer — the reality is intensely interesting and genuinely fascinating. To see the products of one's thought and work take shape and then go into useful productive service, resulting in economic gains to the work, gives a sense of satisfaction and achievement that goes far toward realizing one's ambitions.

ALDRED LECTURES

FREDERICK G. COTTRELL

THE eighth of the Aldred Lectures will be given on February 29, 1924, by Dr. Frederick G. Cottrell who is one of the foremost chemists of the United States. He is at present chairman of the Division of Chemistry and Chemical Technology of the National Research Council. In addition he is widely known in the fields of mining and metallurgy through his connections with the Bureau of Mines and the now famous Cottrell Patents. Doctor Cottrell was born in Oakland, Cal., on January 10, 1877. His early education was obtained at the grammar and high schools of Oakland. He entered the University of California in the fall of 1892 and graduated with the degree of Bachelor of Science in 1896. He then went abroad to complete his education. There he worked in the laboratory of J. H. Van't Hoff at the University of Berlin and also in the laboratory of William Ostwald at the University of Leipzig from which he obtained the degree of Doctor of Philosophy in 1902. After Germany he spent some time in the laboratory of Prof. J. J. Thomson at Cambridge, England. On returning to America, he studied at Harvard and at the Massachusetts Institute of Technology after which he went back to the University of California.

From 1896 to 1897, Doctor Cottrell was the Le Conte fellow at the University of California, during which time he taught chemistry at the Oakland High School. In 1902, after his return, he was given a position as instructor in physical chemistry at the University of California. In 1906 he was promoted to assistant professor of chemistry and held that position until 1911.

While at the University of California Doctor Cottrell's chief contributions to science were researches relating to the electrical precipitation of fume and fine particles suspended in the gases of smelter, blast furnace or cement works flues, and he finally evolved what is known as the Cottrell process for this purpose. This invention was first utilized at the Selby smelter in California for removing fumes from the waste gases of a sulphuric acid plant at the smelter, thereby abating a nuisance that threatened to necessitate shutting down the works. Since that time this electrical precipitation process has been installed at other smelters to remove fume and solid particles contained in escaping gases, and it has also been used successfully at cement plants, notably near Riverside, California, to prevent the dust from the calcining kilns from damaging nearby orange groves and vegetation.

Today the Cottrell process of fume and dust removal is in world-wide use, and is recovering materials heretofore

DR. FREDERICK G. COTTRELL

wasted to the value of many thousands of dollars. One of the recent installations is at a large smelting plant in Japan; while the largest installation is at the Anaconda smelter, Anaconda, Montana. Doctor Cottrell, in a desire to encourage scientific research, turned over his extensive patent rights to a non-dividend-paying corporation known as the Research Corporation, a body formed for that purpose. A fundamental requirement in the incorporation is that all net profits shall be devoted to the interests of scientific research.

In 1911 when Dr. J. A. Holmes, the first director of the Bureau of Mines was serving as a member of commissions appointed by the Government to study alleged damages from smoke and fumes from the Selby and the Anaconda smelters, and when the Bureau of Mines was investigating at length, the smelter-smoke problem, Doctor Cottrell, because of his scientific attainments and his special knowledge of metallurgical problems, was appointed chief physical chemist in the Bureau. In 1914 he was appointed chief chemist, in 1916 chief metallurgist, in 1919 assistant director, and in 1920 director of the United States Bureau of Mines. Although there was much agitation for a mining engineer to head the Bureau of Mines, at that time Doctor Cottrell's appointment met with widespread approval because of his knowledge and ability.

Aside from his work on smelter smoke, Doctor Cottrell has been deeply interested in and intimately connected with work on the separation and purification of gases by liquefaction and fractional distillation. During the World War and subsequently, the development of the Norton or Bureau of Mines process for recovery of helium from natural gas has been his special care, and it was chiefly through his efforts that a plant for recovering helium on a large scale for military aeronautics has been erected near Petrolia, Texas. On January 1, 1921 he was appointed chairman of the Division of Chemistry and Chemical Technology of the National Research Council and holds that position at present.

Doctor Cottrell is a member of the following societies: American Chemical Society, the Mining and Metallurgy Society of America, the American Electro-Chemical Society, the American Institute of Mining and Metallurgical Engineers, Societe de Chimie Industrielle, and (honorary) Phi Beta Kappa, Alpha Chi Sigma. He was awarded the Perkin Medal by the New York Section of the Society of Chemical Industry in 1919 in recognition of his work on electrical precipitation. He was also awarded the Willard Gibbs medal for pure and applied chemistry on May, 1920 by the Chicago Section of the American Chemical Society.

JOSEPH W. POWELL

THE fifth Aldred Lecture was given on January 18, 1924 by Joseph Wright Powell, former president of the United States Shipping Board Emergency Fleet Corporation and a man widely known in the marine world.

Mr. Powell was born in Oswego, New York, on February 15, 1877; the son of Elisha Barclay and Addie Wright Powell. He obtained his early

JOSEPH WRIGHT POWELL

education in Oswego where he attended grammar and high schools.

At the tender age of sixteen he entered the United States Naval Academy and spent four years of hard training there, graduating in 1897. Mr. Powell then became interested in shipbuilding and took a two-year special graduate course in naval architecture at the Academy. In 1899 he went to Scotland to pursue his studies further and graduated from the University of Glasgow in 1900. During this time he saw active service with the Navy in the Spanish-American War.

From the time of the Spanish-American War until 1906, Mr. Powell held the position of Assistant Naval Constructor with the United States Navy. Here he worked on the design of naval ships. From 1906 to 1914 he was the president of Cramp's Shipbuilding Corporation at Quincy, Massachusetts. He then took the position of president of the Fore River Shipbuilding Corporation and held it until 1921. During part of this time he was vice-president of the Bethlehem Shipbuilding Corporation, Limited.

In 1921 Mr. Powell was appointed president of the United States Shipping Board Emergency Fleet Corporation. He held this position until very recently. During that time the Emergency Fleet Corporation built ships in quantity production and at unprecedented speed, at the same time carrying on such related activities as proper housing and transporting of ship workers, the supplying and shipment of necessary material, completing all shipyards, etc., all of which was a stupendous task. After the first stage of the work had been passed, namely, construction for the war emergency, the second stage was entered into, that of building up a well-balanced fleet for the American merchant marine. Hasty construction was eliminated and it was therefore possible to give greater attention to supervision and details. Contracts for ships not actually needed for a well-balanced merchant marine were cancelled. The program was culminated with the completion of modern combination passenger-cargo vessels.

Mr. Powell has been president of the Council of American Shipbuilders, Inc. since 1920. He is at present a member of the board of managers of the American Bureau of Shipping and a director of the United States Merchant Marine League. He is also a member of the Society of Naval Architects and Marine Engineers and vice-president of the Institute of Naval Architects.

RALPH BUDD

THE sixth of the Aldred Lectures was delivered by Ralph Budd on February 1, 1924. Mr. Budd is president of the Great Northern Railway and is prominent in the railroad world.

Ralph Budd was born in Waterloo, Iowa, on August 20, 1877, the son of Charles Wesley and Mary Warner Budd. He went to the grammar and high schools of Waterloo where the greater part of his youth was spent.

In 1895 he went away to college at Des Moines. Here he entered the Highland Park College from which he graduated in 1899 with the degree of Bachelor of Science in Civil Engineering.

Mr. Budd took a position in the engineering department of the Chicago, Great Western Railway in 1899 and stayed with them until 1902. During that time he advanced to the position of assistant engineer of the railroad. In 1902 he was road master of the Chicago, Rock Island and Pacific Railway. He was advanced in a short time to general superintendent and finally to construction and division engineer. His next position was chief engineer of the Panama Railroad at Colon, Panama from 1906 until 1909. From 1909 to 1912 he was chief engineer for the Oregon Trunk Railway and the Spokane, Portland & Seattle Railway and also the Spokane & Inland Empire Railroad.

In 1913 Mr. Budd commenced relations with the Great Northern Railway in the capacity of assistant to the president and chief engineer of that railway. He was promoted to executive vice-president in 1918 and finally chosen president in October, 1919, which position he has held ever since.

Reports show that the Great Northern Railway does some hundred and fifty millions of dollars worth of business a year. The carrying of iron ore from the ore docks at the head of the Lakes to various points

RALPH BUDD

west constitutes about forty-two per cent of their entire freight tonnage.

Mr. Budd is well known in railroad circles of the west and northwest. Besides membership in various railroad organizations, he is a member of the American Society of Civil Engineers and the American Railway Engineers Association. His home is in St. Paul, Minnesota.

RALPH MODJESKI

ONE of the most prominent bridge engineers in the country will deliver the seventh of the Aldred series on February 15, 1924. Dr. Ralph Modjeski is a man of distinguished ancestry with natural talents which would make him personally distinguished in many different lines of endeavor, if he was able to give them the requisite attention. His life, however, has been devoted with energy and industry to the particular work of designing and constructing bridges.

Doctor Modjeski was born in Cracow, Poland, on January 27, 1861. His father's name is Gustav Sinnmayor Modrzejewski and his mother's maiden name, Helena Opid. She changed her name for convenience to that of Modjeska on becoming a citizen of the United States. She made her home in America and was known as a dramatic artist. She died in April, 1908.

Doctor Modjeski was naturalized an American citizen in 1883 when he took out final papers. He attended grammar and high schools in Cracow up to 1876, at which time he came to America with his mother. In 1878 he went to Paris, France, and attended the government college "Écôle des Ponts et Chaussees." He graduated with the degree of Civil Engineer at the head of his class in 1885. That summer he returned to America and received his first engagement with George S. Morison, Civil Engineer, as assistant engineer on the construction of the Union Pacific Bridge at Omaha, Nebraska. He remained with Morison in various capacities until 1892. During these years he occupied the position of assistant engineer on the Omaha Bridge, from 1885 to 1887, inspector in the shops for bridge work, 1887 to 1889, at Athens, Pennsylvania; later chief draftsman in Morison's office in Chicago, 1889 to 1891. During this time he was in charge of design of the Mississippi River Bridge at Memphis. In 1891 he became chief inspector at the shops for the Memphis bridge superstructure. In 1892 he was assistant engineer of construction of the Memphis Bridge. Early in 1893 he opened an office in Chicago as a civil engineer in independent practice.

The first large bridge designed and constructed by Doctor Modjeski was the government bridge at Rock Island, Illinois, over the Mississippi River, which is a double-track railway and highway structure. Then followed the reconstruction of the Bismarck Bridge at Bismarck, North Dakota, over the Missouri River, and later the Thebes Bridge, over the Mississippi River at Thebes, Ill. This bridge was built under the firm name of Noble & Modjeski, the late Alfred Noble was one of the partners. The bridge was commenced in 1903 and completed in 1905. Then came the Columbia River Bridge and Willamette River Bridge, both in Oregon, for the Spokane, Portland and Seattle Railway. These bridges, costing over $4,000,000, were commenced in 1905 and completed in 1908. Then came the McKinley Bridge over the Mississippi River at St. Louis, the Columbia River Bridge at Celilo, Ore., for the Oregon Trunk Railway, as well as other bridges for that company, including a

DR. RALPH MODJESKI

340-foot arch over the Crooked River. Almost immediately after came the Broadway Bridge over the Willamette River in the City of Portland, Ore.

The bridges more recently completed are the new double-track railroad and highway bridge at Memphis, Tenn.; the single-track railroad and highway bridge over the Mississippi River at Keokuk, Ia.; the Metropolis Bridge over the Ohio River at Metropolis, Ill. On this last-mentioned bridge, he was employed as consulting engineer in preparation of designs in conjunction with the late C. H. Cartlidge until his death, when the bridge was turned over to him.

Doctor Modjeski was employed as consulting engineer for the New York, New Haven and Hartford Railroad on their recently completed Thames River Bridge at New London, Conn. He was in charge of reinforcing the present Poughkeepsie Bridge over the Hudson River. He has been a member ever since its formation in 1908 of the Board of Engineers, appointed by the Dominion Government of Canada, for the reconstruction of the Quebec Bridge, the longest span in the world. He made a complete report for the New York Bridge Department on the strength of the New Manhattan Bridge in New York (1909). The Cherry Street Bridge at Toledo, O., which is a concrete arch structure, was built under his direction and the plans previously prepared by other parties were modified by him. During his independent practice he has acted as consulting engineer for various railroads and corporations on smaller structures. He prepared two sets of standard plans of spans from ten feet to two hundred fifty feet in length for the Northern Pacific Railroad. In 1916 he was a member of a commission appointed by the Public Service Corporation of New Jersey to determine the feasibility of a vehicular tunnel under the Hudson River, including preliminary plans and estimates. He designed and constructed a fireproof warehouse for the Rock Island Arsenal at Rock Island, Ill.

The aggregate cost of the completed structures in the above list exceeds forty million dollars.

In addition he was appointed chairman of the Board of Engineers to report on the location and prepare preliminary plans for a bridge between Philadelphia and Camden. This bridge involves an expense of some $28,000,000. The report was completed on June 9, 1921, and construction is nearing completion on this bridge, which is known as the Delaware River Bridge.

In 1911 he received an honorary degree of Doctor of Engineering at the University of Illinois. In May, 1922, he was awarded the Franklin Medal and Certificate of Honorary Membership to the Franklin Institute. He is a member of the following societies: American Society of Civil Engineers, The Engineering Institute of Canada, British Institution of Civil Engineers, American Institute of Consulting Engineers, past president and member of the Western Society of Engineers, Society for the Promotion of Engineering Education, the French Association of Engineers.

The list of some of Doctor Modjeski's works which has been given very briefly here, indicates many communities who may claim him as a citizen, but engineers are not restricted to localities — their citizenship lies where their talents are most needed and so it has been with Doctor Modjeski.

MONTHLY NEWS

Why the Navy Uses Electric Drive for Battleships. Although vessels were propelled by electricity as early as 1893, the first important installation of this drive was on the collier *Jupiter* in 1913. Two other colliers were constructed at the same time, one equipped with geared turbines and the other with reciprocating engines. The testing of these three methods of propulsion demonstrated that geared turbines were desirable in the vessels below the capital class, but that electric drive was superior for the vessels of the capital class.

The most important advantage of the electric drive for battleships is the fact that the steam part of the propelling machinery is not connected with the propellers by means of shafting. The turbine generators and auxiliaries can therefore be placed in absolutely watertight compartments, where they receive the maximum amount of protection, while the propeller motors can be so placed that the propeller shafts penetrate the smallest number of bulkheads, reducing to a minimum the danger of flooding in case a ship is struck by torpedoes or shells. There are other advantages of the electric drive as compared with the steam drive. The piping can be given better protection. The propeller shafts being shorter are more reliable. Either turbine generator can be used alone for ordinary cruising speeds permitting repairs on the other one. Excellent economy of operation can be obtained, especially at cruising speeds. Finally, full power, instead of only about half power, can be applied for reversing the propellers. This provides a high degree of maneuvering power that is of immense value under modern war conditions.—*Westinghouse Marine Log.*

Wider Use of Labor-Saving Devices in Japan. One of the noteworthy developments that have taken place in Japan following the recent disaster has been the large scale introduction of more modern labor-saving devices, such as automobile trucks, steam shovels and other mechanical devices designed to take the place of human labor, says the Far Eastern Division of the Department of Commerce. The necessity for quick action and the lack of manual labor were largely responsible for this move. Contrary to popular opinion, Japanese day labor has never been plentiful or, in late years, cheap. The speed and efficiency with which the debris was cleared away has been an eye opener to the Japanese, and the effects of this innovation should be far reaching; and may cut the gordian knot of high wages and high production costs in industry, at the same time opening a market for our specialized highly automatic machinery.

As soon as the streets were cleared and material available, temporary structures were put up with amazing speed. The Metropolitan police board reported that they were going up at the rate of 1,800 per day during October, and that at the end of that month, the total number in Tokyo amounted to 92,087, half of the number destroyed. The majority of these temporary buildings were small, sufficient to hold but one family, but a good number of them took the form of barracks, each of which is capable of sheltering a good number. As nearly one-third of the population were killed or have moved away, Tokyo should be fully housed very shortly. The construction of temporary shelters will continue for some time to come, however, as the former residents are returning to Tokyo at the rate of 6,800 per day and will have to be steadily provided for.

It is reported that land values have taken a considerable drop throughout the city since the earthquake. Land quoted at 1,000 yen per taubo (about 36 square feet) prior to the disaster is now being appraised at around 200 yen, since improvements have been destroyed. This fact will make it easier for the Capital Reconstruction Board to carry out condemnation for street and park plans and simplify matters considerably.

Metric Standards Bill Introduced in Congress. Among the first bills introduced in the new session of Congress are the Metric Standards Bills, providing for gradual adoption of the metric units of weights and measures in merchandising.

The metric bill was introduced in the House of Representatives by Hon. Fred A. Britten of Illinois, and in the Senate by Hon. Edwin F. Ladd of North Dakota. The legislatures of these States, in company with many others, have petitioned Congress to enact metric standards laws. More than 100,000 petitions, directly representing several millions of voters, are pending before Congress, urging favorable action on adoption of the world units for weighing and measuring.

The simple decimal nature of the metric system is ingeniously stressed in the numbers of the metric bills themselves — Congressman Britten's being number 10 in the house and Senator Ladd's bill number 100 in the Senate.

According to the provisions of the Britten-Ladd bill, the buying and selling of goods, wares and merchandise will be in terms of the metric units after a period of ten years. Manufacturers are to use whatever measures they choose in production, the bill providing "That nothing in this act shall be understood or construed as applying to the construction or use in the arts, manufacture or industry of any specification or drawing, tool, machine, or other appliance or implement designed, constructed or graduated in any desired system." This safeguards manufacturing interests. Hundreds of great industrial concerns are urging the metric legislation on this basis.

Rules and regulations for the enforcement of the Metric act are to be made and promulgated by the United States Secretary of Commerce.

The Rare Metals are becoming increasingly important to our industries, the Bureau of Mines points out. Rare metal alloys have properties which indicate that we are only on the threshold of the possibilities of their utilization, not only in making nonferrous alloys, but also as special steels. Not only are their uses broadening rapidly, but the metals are affecting our industries in other ways. The oxides and some salts are used as pigments; others have medicinal value. The pure metals are made into filaments for incandescent lamps, and targets for X-ray tubes. By their efficient use in alloys, the weight of automobiles is reduced, and the wear and tear on tires and roads is thus minimized; in machine shops they help to give greater efficiency to tools and reduce production costs.

Joint Reconstruction of Tokyo. A building construction company is now being projected in Tokyo for the purpose of undertaking "to do civil engineering, construction work and to give loans to building contractors for construction expenses and also to import materials from foreign countries to supply the demands," according to a tentative prospectus received by the Far Eastern Division of the Bureau of Foreign and Domestic Commerce from its representative at Tokyo.

This new company is said to include that previously projected and sponsored by the Tokyo Chamber of Commerce which was to specialize in the construction of industrial and commercial buildings on the unit basis designed to withstand earthquake shocks.

The new corporation will be known as the "Nichi-Bei Doboku Kabushiki Kaisha" or "Japanese-American Engineers' and Contractors' Corporation" and will be financed and controlled jointly by Americans and Japanese. Head offices will be established in Tokyo with branches in other parts of Japan as may be deemed necessary. The corporation is to be capitalized at 100,000,000 yen ($50,000,000) half of which amount, according to present plans, will be called into the treasury of the company when incorporation is actually effected. Stock certificates are to be issued in denominations of 10, 50, 100, and 1,000 yen and will be printed in both English and Japanese.

The shares will be divided equally between Japanese and American citizens, insuring joint control of the venture.

Technical skill, machinery, and building materials needed in carrying out the plans of the corporation are to be secured in the United States according to present plans.

Gasoline Recovery. Methods by which enormous volumes of gasoline now lost in ordinary petroleum refining processes may be recovered by the condensation of still vapors are outlined in detail by D. B. Dow, associate organic chemist, Department of the Interior. At thirteen refineries from which data were collected 128,651 gallons of gasoline, representing an average increased recovery of nearly half a gallon of gasoline per barrel of crude oil, were being recovered daily from uncondensed vapors. The figures represent the increased conversion into gasoline of 1.05 per cent of the crude oil charged, which would otherwise have been lost.

Several different processes can be used to recover gasoline from still vapors: Compression is the more common process. The gas is compressed to a high pressure and cooled. Gasoline vapors are condensed and collected, but any permanent gas present is not materially affected. In the absorption process the gas is passed through a distillate of lower Baumé gravity that absorbs the gasoline. When naphtha is used as the absorbent the naphtha is raised in Baumé gravity to the point where it may be marketed as gasoline. When a heavy gas-oil distillate is used, the gasoline is recovered from the gas oil by distillation. A combination of the two methods is used when the gas after compression is passed through absorption towers.

Hexamethylenetriperoxidiamine. Laboratory tests to determine the detonating values of hexamethylenetriperoxidiamine are being conducted by the Department of the Interior at the Pittsburg Experiment Station of the Bureau of Mines. Exposure of specimens of this material to saturated air up to one month caused no change. It was then kept under water for one month without change. As a detonator it is less sensitive than fulminate, which requires one-half cm. on the small impact apparatus, whereas hexamethylenetriperoxidiamine requires three cm. Hence it may be useful in armor-piercing shell. Commercially it may also find use because, while it costs twice as much as fulminate, only one third is required for equal work. The fulminate deteriorates and causes misfires when exposed to moisture, which is a disadvantage, although the technique of preparing and using fulminate detonators is developed to a point where troubles for moisture are practically nil. Tests to determine its tendency to hydrolyze show that it is stable at ordinary temperatures both when kept under water and in a saturated atmosphere. Experiments showed that it would not become "dead pressed" under a pressure of 11,000 pounds per square inch, while a mercury fulminate only burns after that pressure. A report on this work is being written for publication.

Electric Ferryboats. The Golden Gate Ferry Company of San Francisco has placed a repeat order with the General Electric Company for complete electric propulsion and control machinery for two new steel hull, double-ended ferryboats. These craft will be operated in the same manner as the *Golden Gate* and *Golden West*, equipped with electric propulsion and control machinery and now running between Sausalito and San Francisco.

The two new ferryboats will be somewhat larger than the previous craft, having, instead of two main generating sets, three Werkspoor Diesel engines each direct-connected to a 270-kilowatt, 250-volt, direct current generator. A 30-kilowatt auxiliary generator being mounted on an extension of each main generator shaft.

Two 950/150 s.h.p. 180/150 r.p.m. 750-volt, intermittently rated motors will be mounted in each end of the boats and direct-connected to the propeller shafts. These motors will have a constant rating of 900 s.h.p. at 180 r.p.m. Ward Leonard type of voltage control will be employed and both pilot house and engine room control will be available.

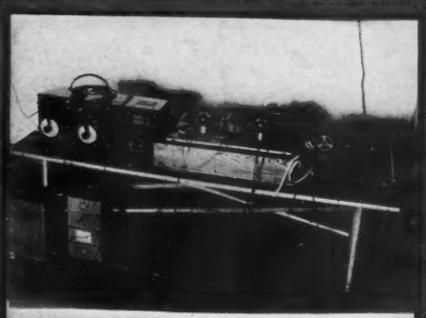
The Golden Gate Ferry Company with the installation of the first two electrically equipped boats, the *Golden Gate* and *Golden West*, inaugurated a radical departure in ferryboat construction, these being the first double-ended craft where each propeller was driven separately.

The Detroit Street Railway will install soon for use on its Woodward Avenue line a three-car articulated train, built by the Cincinnati Car Company and equipped with four motors, built by the General Electric Company. This train will consist of three car bodies operating on four trucks, one truck being at each end of the train and one each divided between two of the cars and used in common by both.

The three-car articulated unit is designed to give more seating capacity in the same space and its adoption by the Detroit Street Railway will be the first use of electric drive on this type of train and first in this country to use the articulated unit. Trains of this type have been operating in England on the Great Northern Railway, a steam road, for several years, where they were used in units of from two to seven cars, articulated. The passage between cars is so arranged that, regardless of the position of the cars on curves, there is always a free entrance from one car to another. This is made possible by the use of a steel drum, mounted on the truck, around the periphery of which slides the end of the car body, this end being constructed in such a manner as to fit around the circumference of the drum.

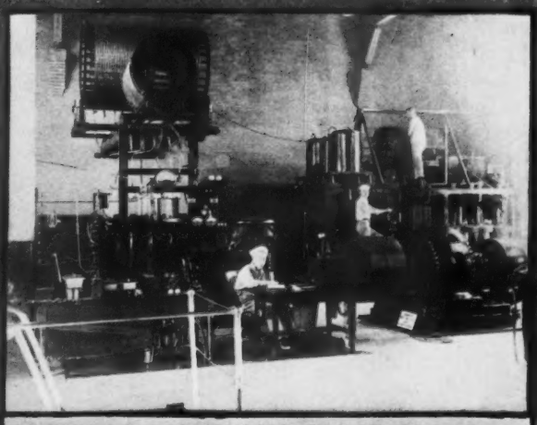
The total weight of the train is 72,000 pounds "ready to roll." It seats 136 persons. The average seating capacity of the standard car in use in this country is about 48 persons. With the 72,000 pounds weight and a seating capacity of 136 persons, the dead weight is 530 pounds per seat, which indicates an exceptionally light construction.

Some of the advantages which are expected to result from the adoption of this type of train are a reduction in weight, a reduction in first cost, a reduction in operating cost and better riding qualities.

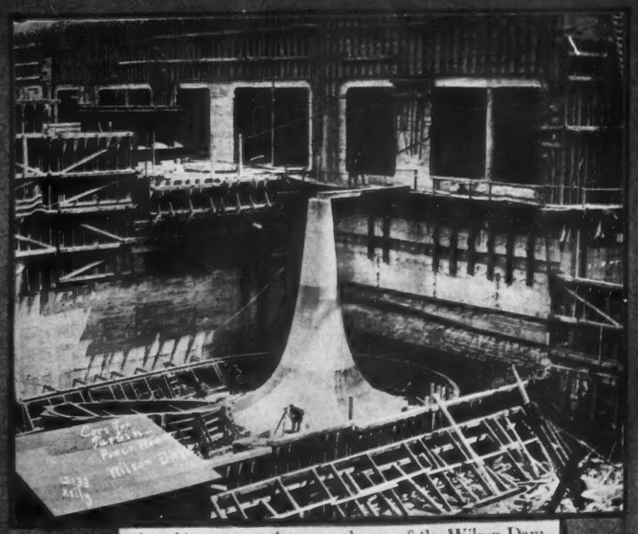


The radio sets installed in Navy planes, showing the typewriting apparatus used as the sending set.
International Newsreel.

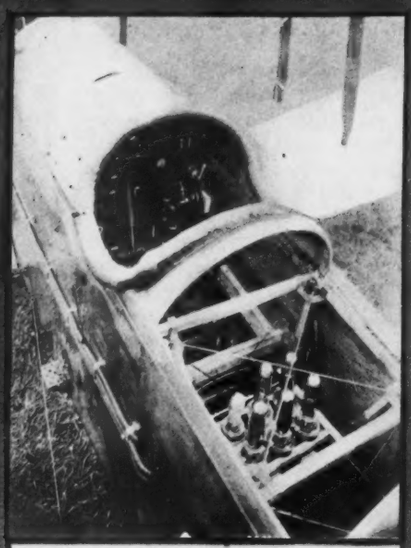
Coffer No. 6 of the Wilson Dam across the Tennessee River.



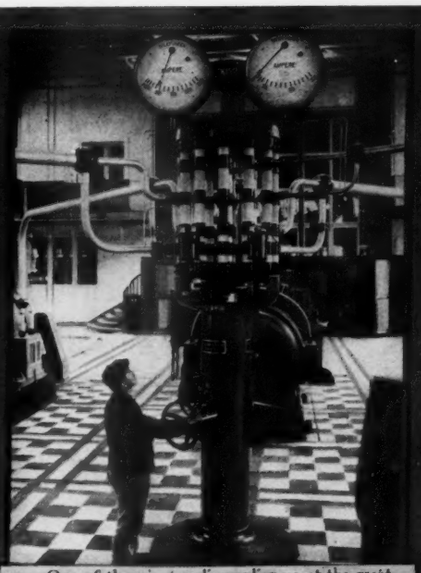
The interior of the Naval Radio Station, NAA, showing the powerful apparatus that is used.
International Newsreel.



A turbine core at the power house of the Wilson Dam.



The cockpit of a U. S. Mail plane, showing the receiving and transmitting apparatus, antenna reel, and vacuum tubes.



One of the giant radio appliances at the great radio station at Neuen, Germany. Signals from this station traversed the Atlantic in one-twentieth of a second.

The Japan Oil Building after the great Japanese earthquake. Of very recent construction, it stood the test well. No windows were broken and the steel frame was intact with no shifting.

A Super-Heterodyne receiving set at the permanent Radio Fair. It can get practically everything from as far as the European coast.

International Newsreel

Damage to the Yusen Building was confined to the brickwork and facing. Most of the modern buildings of Tokio only sustained damage to their exterior.

The Marunouchi Building intact except for portions of the outer tiling.

EDITORIALS

STANDARDIZATION

A GREAT deal of attention is being paid at present to the question of standardization. Not that the subject is entirely new or very striking; quite to the contrary, it has been slowly developing in more or less of a haphazard manner in the business world for some time. With the growth of our all-powerful and magnificent industrial system, however, standardization has appeared on the horizon as the chief factor in the system. In fact, so much consideration and promotion is being given to it that we feel its influence in our education, religion and even in our social relations. Undoubtedly engineers have played a large part, consciously or unconsciously, in bringing this condition about. It is therefore fitting and proper that they should consider the effects of their work on society as seen by one who resides outside of the "system"— a deep thinker.

Some time ago — just long enough so that most engineers and business men have forgotten about it — there was published in the *Boston Herald* and other newspapers throughout the country an article on the tendency towards standardization. Dr. Charles W. Eliot, president-emeritus of Harvard University, was the author of that article which is given here in full as follows:

"A new blight is afflicting education and industries in the United States, particularly the educational part of industries. Its name is standardization, and there is a very general movement to give it application in a great variety of American activities. The blight seems to have started in the industrial domain. To save time and therefore money, and to increase the productiveness of a given plant, the movements of the individual operative were carefully studied with a view to reduce the number of his movements and changes of posture, and to increase the automatic and repetitive quality of his work. The object was larger production at lower cost, and this object was gained; but the inevitable result was the destruction of the interest of the workman in his work. For the lifelong interest of the hand worker in the varied products of his skill was substituted the intolerable dullness of tending machinery on a standardized 'stop watch' program.

"Soon standardization began to affect the school and college programs, the conditions of admission to college, and the qualification for degrees. It limited injuriously freedom of election of studies in both school and college. It also affected the method of instruction in every school or college course, particularly in the lower or more elementary courses. Thereby, the liberty of the individual teacher, particularly in the lower grades, was restricted, and the expedient liberties of pupils and students were also confined.

"It is obvious that standardization has become a dangerous adversary of progress in both education and industry. The ideal in education is to develop the utmost possible variety of individual attainment and of group attainment; just as the true goal of democracy is the free development of the utmost variety of capacity in the individual citizen. Uniformity in the attainment of skill, and therefore in earnings, leads not to joy in work but to discontent and unhappiness in the worker. The true educational goal is the utmost development of the individual's capacity or power, not in childhood and adolescence alone, but all through life. Fixed standards in labor, in study, in modes of family life or of community life are downright enemies of progress for the body, mind and soul of man. That doctrine is as true in churches, courts, and legislatures as it is in schools and factories. It is sometimes desirable to suggest minima as respects age, intelligence or productive capacity, but never maxima.

"It will be for the happiness of the American people to look carefully into the effects of standardization in both the national education and the national industries. It has already gone too far. Although some pecuniary economies can be effected by standardizing processes in both schools and factories, their physical and moral effects are unquestionably bad. As soon as any process in state or church proves to be injurious to the physical or mental quality of the population a genuine democracy should set to work to modify or suppress it.

"The reason that the majority of the American people is today unchurched is that the various Christian denominations or church institutions from the first century to the nineteenth set up fixed standards of belief and practice based on what were supposed to be final revelations. Since experimental science began, about one hundred fifty years ago, to contribute powerfully to the progress of mankind, those fixed standards in the church have become discredited among thinking people; but since the religious instinct is universal and irrepressible in man, a diligent search is now going on for a church free from standardization. This search and the co-operative management of the fundamental industries are the most promising efforts of the twentieth century."

It should not be concluded from this article of Dr. Eliot's that standardization is entirely useless and should be done away with. Obviously, such a procedure would produce a situation little better than chaos. The point to be gleaned is that standardization should not be allowed to dominate our every act and thought. Furthermore, certain problems of society can never be standardized unless the human race degenerates into a race of machine-like puppets characterized so aptly in a current play under the name of "Robots." What we really need is less standardization and more true standards — only those which have been tested by actual experience and interpreted by able minds which are unbiased by the standardization of the "system."

To all forwards who are playing center

"THE little fellow hasn't got the reach. Why don't they put him at forward where he belongs?" You have heard comment like that about some mis-positioned player.

Just look out they don't talk that way about you—not in athletics but in your field of work after college.

The world is full of doctors who should have been lawyers, and lawyers who should have been writers—men who can't do their best work because they haven't got the reach.

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Number 35 of a series

PROGRESS IN ARTIFICIAL SILKS

(*Continued from page 309*)

per cent of the ammonia and ninety-five per cent of the copper has been effected without excessive expense. The soda lye in the viscose until now, after having been neutralized by the sulphuric acid of the spinning bath, has been wasted. It was suggested that the sulphate of Na can be recovered from the spinning bath by cooling it and so causing a dissociation of the bisulphate in the spinning bath into neutral sulphate and sulphuric acid. This method, however, was faulty and very expensive. The fact is that the sulphates produced do not remain in the spinning bath, but are formed only on the threads emerging from it and received on the spools or the like. Threads, as a rule, are only slightly acid when the acid has penetrated the thread and entirely neutralized the alkali of the viscose. In washing with water the process of removing the neutral salt from the inner parts of the threads takes a long-time and much water is required.

The finer threads require a more concentrated acid salt bath, and acid and salt have to be added continually. In the new Bronnert process water acidulated with sulphuric acid is employed to such an extent that all sulphate in the threads is converted into the easily soluble bisulphate, which may easily be washed out on the addition of more sulphuric acid.

After using the same restricted quantity of acidulated water twice, an equilibrium is produced between the content of the bisulphate in the threads and that in the liquid. A further washing would not extract more of the salt, and so the threads are squeezed out and the liquid falling from them collected. After concentrating to a certain degree the hot strong acid, bisulphate of soda is again added to the spinning bath, instead of adding fresh sulphuric acid and neutral sulphate or bisulphate as was formerly done.

This process has proved most economical and gives the best result when mixed ammonium and sodium salts are used together in the spinning bath.

A spinning bath of pure acid yields threads with an irregular round cross section. The same occurs when acid is in excess over salt in the spinning bath. The section differs completely when the salt is in excess and produces the form of a star with serrated outlines. If the salt is in great excess the thread appears to be coagulated more slowly and takes the form of a bean, the serrated outline being nevertheless maintained. It is caused by a shrinkage which forces the water out of the inner parts of the thread into the surrounding salt solution. It is possible to observe from these characteristic forms which process has been used in the spinning, and it is also most important for the specific lustre of the thread. The annular bulbs act like prisms to the light and increase or decrease the transparency of the thread. A higher temperature of the spinning bath hastens the plasmolytic process, shrinkage takes place in a different way, and different effects are produced.

In spinning from ammonium salt with a little acid, threads of a perfectly round circumference are produced, and, although these have slightly less covering power they are of even transparency and brilliance and of the highest tensile strength, which makes them suitable for use in braids and the like.

A great variation has been found in the strengths of even first-class artificial silks, especially when dry. This may be caused by the irregularity of the cross section and by defective spinning, which may be brought about in the following way. It has been found that the apertures become choked not only when impurities, because of bad filtering, are in suspension in the viscose, but also when the minimum concentration necessary for the special counts does not exist at each aperture. This becomes worse when some of the apertures are choked, and other apertures produce coarser threads owing to the additional feed of viscose. It is most important, therefore, to have the bath circulating and of constant composition and temperature. In the best silk resulting from one kind of viscose, when all the spinning factors are carefully arranged, the filaments all show the same even section. This may be realized in the acid wet spinning process with the greatest ease and better than in the Chardonnet process when spinning collodion direct into hot air.

The short fiber received fresh impulse from the above described improvements of Professor Bronnert. It may be spun to any count, and when it is fine may be mixed with schappe to a certain degree or may be spun alone with a yarn resembling schappe yarn. These yarns at the same weight naturally exhibit a greater volume than the hanks of artificial silk yarn, even when they are of the same count. Although the luster partly disappears during the combining operation, articles manufactured from the new mixed or unmixed yarns have a remarkable "feel" and brightness, and if possible to be produced at a low price and on a large scale they may prove of great assistance to the textile industry.

Processes have been further cheapened by another Bronnert process. It is a well-known fact that the usual method of drying gelatinous, freshly precipitated and washed cellulose threads had to be carried on with extreme care. When the threads were placed too near to the steam pipes or radiators, producing the higher temperature, the threads became brown, and the cellulose was altered, which meant that only relatively low temperatures could be employed and of course the drying process took much longer. Much room is required and the cost of fuel is excessive. Until now the drying temperature scarcely exceeded 60 degrees C.

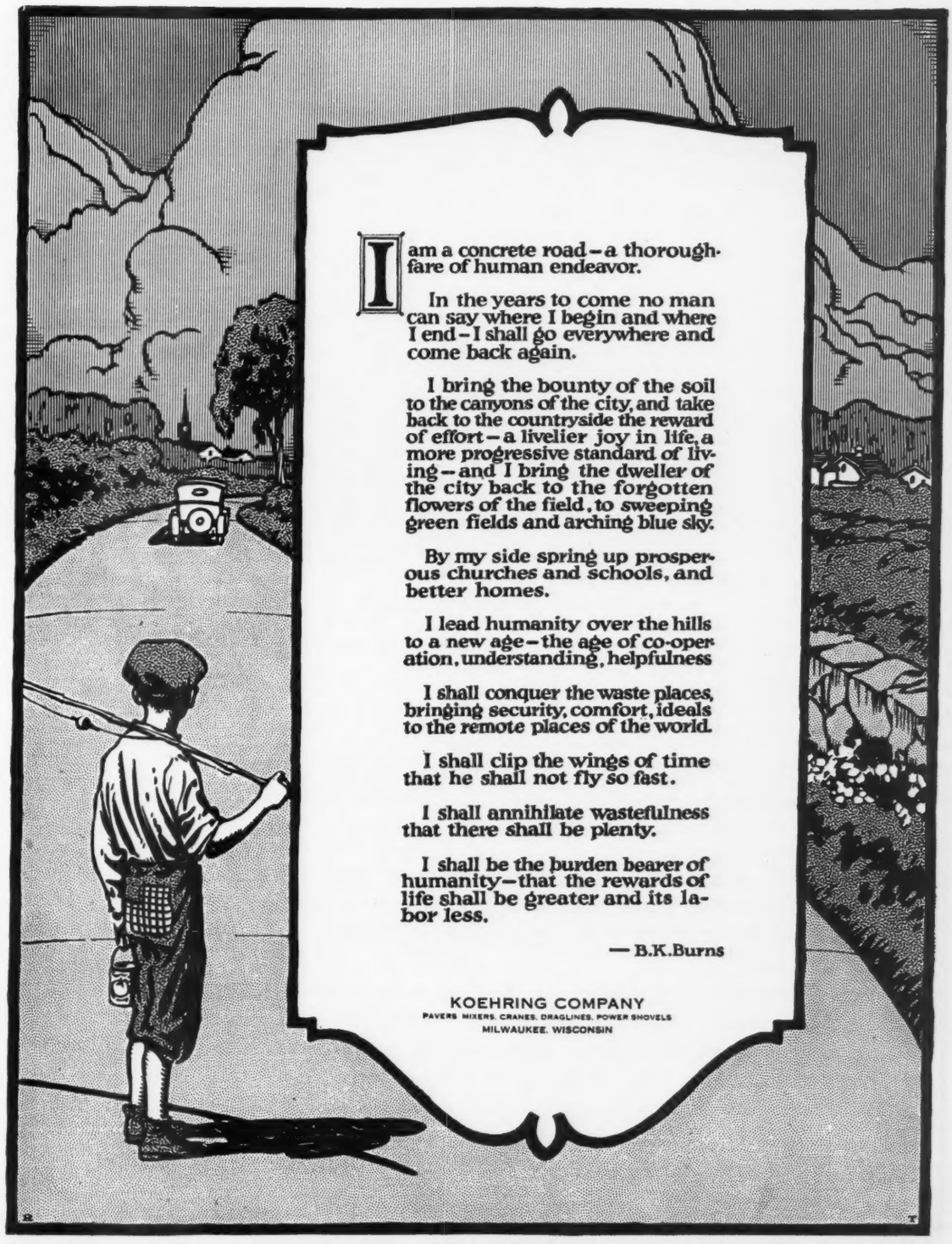
It has been suggested that the water which was supposed to be chemically combined with the cellulose be removed by steaming the threads, but this was a very tedious process. It has been pointed out that the same gelatinous threads when well washed from the salts and from the acid may be exposed to hot air up to 140 degrees C. without becoming brown or producing an unevenness in dyeing afterwards, provided that care is taken that the air circulating in the drying chamber maintains an equal velocity so that no warmer or cooler parts, caused by the evaporating water, exist in any section of the drying chamber.

It makes no difference if the temperature is not the same from one cross section to another, which may quite easily happen when the hot air becomes more and more saturated with water, and consequently cooled, but it is the usual practice to keep the air at the same temperature as when admitted by reheating it from time to time in its passage through the drying apparatus.

The escaping air at the end of the process is practically at the same temperature at which it entered and it contains the maximum amount of water which is compatible for complete drying. It must be obvious to anyone knowing the great dissolving power of air, which becomes greater with increasing temperature, what a great economy of fuel must take place, for less air at a higher temperature requires heating for a relatively shorter time in the drying process.

These improvements are of especial significance for short fiber, which must be produced at a low cost on a very large scale if a constant market is to be created.

A complete index of Volume IV will appear in the March issue.


I am a concrete road – a thoroughfare of human endeavor.
In the years to come no man can say where I begin and where I end – I shall go everywhere and come back again.
I bring the bounty of the soil to the canyons of the city, and take back to the countryside the reward of effort – a livelier joy in life, a more progressive standard of living – and I bring the dweller of the city back to the forgotten flowers of the field, to sweeping green fields and arching blue sky.
By my side spring up prosperous churches and schools, and better homes.
I lead humanity over the hills to a new age – the age of co-operation, understanding, helpfulness
I shall conquer the waste places, bringing security, comfort, ideals to the remote places of the world.
I shall clip the wings of time that he shall not fly so fast.
I shall annihilate wastefulness that there shall be plenty.
I shall be the burden bearer of humanity – that the rewards of life shall be greater and its labor less.
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CONSTRUCTION OF THE MOFFAT TUNNEL

(*Continued from page 315*)

the Pacific Slope. Therefore, for the benefit of all concerned, it was easy to see that the pioneer tunnel system was best adapted to the conditions and requirements of the case.

In this system, the size and form of the pioneer tunnel is determined by the character of the rock encountered, the best cross-section being the one that will give the highest rate of speed consistent with economy. In the pioneer tunnel at Rogers Pass, where exceptionally favorable conditions for driving existed, speeds ranging from 600 to 900 feet per month were attained.

The main tunnel heading is not driven from the railway tunnel, but by cross-cuts from the pioneer tunnel, as shown in Fig. 3, therefore the heading can be driven simultaneously in opposite directions from the intersection of each cross-cut with the line of the main tunnel. From this it follows that the heading may be driven with smaller crews and more economical methods and still maintain the same high rate of progress as in the pioneer tunnel.

When the rock is sufficiently hard to stand what is known as "ring shooting," a ring of holes, as shown in Fig. 2, is drilled from the heading to the outline of the main tunnel. The distance between these rings is determined in a measure by the hardness of the rock, but it is usually about five feet. As there is neither travel nor transportation in the completed portion of the heading, drills can be set up at intervals and holes drilled hundreds of feet in advance of the enlarged portion. Delay electric fuses have recently been perfected so that their timing is reasonably accurate and certain, and in blasting operations in the railway tunnel the first or outer ring is charged with explosives fired by No. 1 delay, the second by No. 2, etc., until five rings are loaded. This method is more akin to underground quarrying than mining, as the blasting in each ring breaks into an open face as the charges in the successive rings explode after each other in rapid succession.

The rock exposures over the mountain and the experience gained in driving Roosevelt and Laramie-Poudre tunnels through similar rock and at nearly the same elevation, indicate that it is probable that not over five per cent of the tunnel will require support, and where this is necessary only the best grade of Oregon fir timbers will be used.

The cars used in the railway tunnel construction are the usual side-dump contractors' type, strong enough to withstand the impact of the heavy chunks of rock dropped into them from a cubic yard steam shovel. Cars of this size would be altogether too large and heavy for use in the pioneer tunnel and center heading, where lighter cars of from 18 to 25 cubic feet capacity are generally preferred.

During and since the war the scarcity of labor and high rate of wages have brought about the introduction of mucking machines designed for use in small tunnels like the Pioneer.

These machines are of three distinct types, the cheapest and simplest form being a scraper drawn back and forth with a wire cable operated by a small, portable, pneumatic hoist. This operation is known as "scraping" or "slushing," and the material is dragged up a metal lined incline into the car by these scrapers.

The second class are diminutive compressed-air or electric actuated shovels with some provision for shortening or jack-knifing the boom so that the shovel can be rotated in a narrow space.

The third class is really a combination of the first two, in which the metallic incline leading up to the car is replaced by a conveyor-belt, upon the lower end of which the muck is lifted mechanically with a scoop or shovel.

Each of these types is now represented by highly developed machines, the operation of which is in every way satisfactory.

(*Continued on page 332*)

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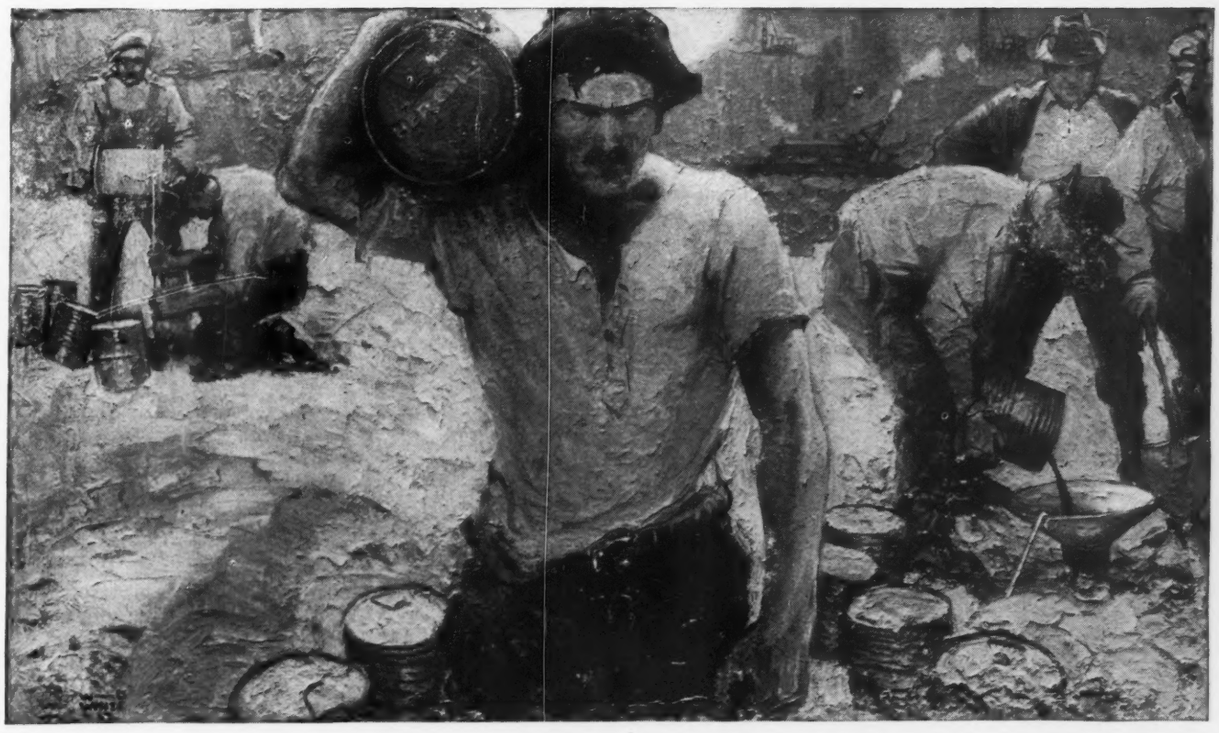

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CONSTRUCTION OF THE MOFFAT TUNNEL

(*Continued from page 330*)

In both the railway and pioneer tunnels the muck trains will be hauled by electric locomotives operated on the usual trolley system, but as the trolley wires cannot safely be carried nearer the face than 400 or 500 feet, the locomotives will carry a storage battery, from which they will receive current to run from the end of the trolley wire to the face.

A great many very elaborate experiments have been made to determine the exact amount of air required for each man in the face, but owing to the fact that the fresh air which is being driven into the heading does not force the products of explosion back in a solid mass, but mixes with them by diffusion, a greater quantity of air than is theoretically required is extremely desirable. Observations made in seventeen tunnels in operation showed that each heading should have 3,600 to 4,000 cubic feet of air per minute to provide not only for pure air in the face, but to force back the products of explosion and drive them out of the tunnel in a reasonable time.

For ventilating purposes, fan blowers, except for very short distances, should never be used, as the amount of air delivered is in inverse proportion to the length of pipe and consequent frictional resistance. Force blowers, preferably of the cycloidal type, should always be installed, as the amount of air delivered at the face from these machines is constant, no matter how great the length of the pipe, though of course the power required to drive them increases with the length of pipe and consequent frictional resistance.

Both air compressors and ventilation blowers will be installed on the multiple unit system, thereby affording ample assurance against breakdowns. Three or four small machines will of course cost somewhat more than one large machine of the same capacity, but when the work is completed their salvage value will be very much greater.

Electric power to operate all machinery at both portals will be furnished by the Colorado Power Company at their wholesale schedule. The power requirements will be about 2,000 h. p. and with a 65% load factor the resultant rate will be one cent per kw-hr.

The Moffat Tunnel Commission has recently purchased from William Ainsworth & Sons, a special triangulation transit reading to ten inches but as the tunnel is on a tangent and the line over the mountain can be carried in four or five sights, no special surveying problems are involved.

Due to the great elevation of the mountain under which the tunnel passes, ventilation by means of an air shaft extending from the apex of the tunnel up to the surface, cannot be considered; therefore, electric haulage through the six-mile bore becomes a necessity. As the freight and passenger trains arrive at the tunnel portals, the locomotive fires will be banked and the entire train, locomotive included, will be pulled through the tunnel by a powerful electric locomotive.

About 230 men will be employed at each end of the tunnel and as their efficiency depends on their experience and skill, every available means will be employed to retain them in continuous service by doing everything possible to promote their safety, health and contentment. Complete waterworks and sewerage systems, the latter discharging into septic tanks, have been installed at both ends of the tunnel. A large steam-heated change and dry room will be erected at each

(*Continued on page 334*)

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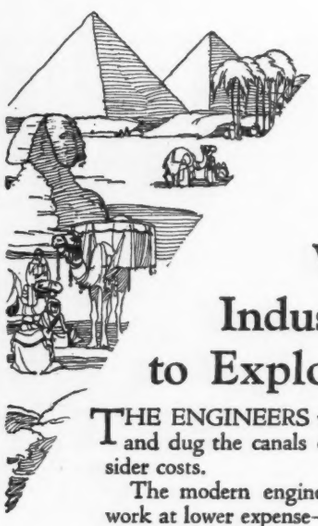
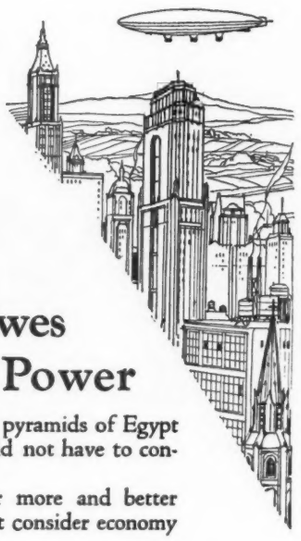

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Explosives Department, Wilmington, Delaware

DU PONT
EXPLOSIVES

MOFFAT TUNNEL

(*Continued from page 332*)

portal, where the men coming off shift will be expected to remove their working clothes, take a shower bath and put on street attire before going out into the open air. Warm, comfortable bunk houses are now being erected for all of the employees and the mess-house will contain the latest devices for high class cooking and quick service. A small hospital will be erected at each portal and the attendant surgeon, in addition to his other duties, will be expected to look after the sanitary welfare of the camp.

For the amusement of the men when off shift, a recreation building will be erected containing a reading room, billiard room and an assembly hall equipped with a loud speaking radiophone and moving picture machine.

Hard times on farms and the decline of mining, due to the low price of silver, have combined to send to the tunnel an exceptionally high class of workmen, and with the system and equipment described there is every reason to expect that the tunnel will be completed within the estimated time and cost.

1923 Adds Big Mileage to Federal-Aid Roadways. Federal-aid roads totalling 8,820 miles were completed during the fiscal year ending June 30, 1923, bringing the total of Federal-aid roads completed to 26,536 miles.

Corrugation Method of Irrigation. The corrugation method of irrigation, which is used extensively in the Northwestern States for watering uncultivated crops, such as small grains and hay, is described in a recent bulletin of the Department of Agriculture. The principle involved in this method is that of allowing small streams of water to flow through narrow, shallow furrows or corrugations long enough to permit a thorough wetting of the soil between the furrows. It is particularly adapted to regions of rather rough topography, but is not recommended for use generally because it is wasteful of water, time and labor.

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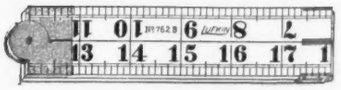

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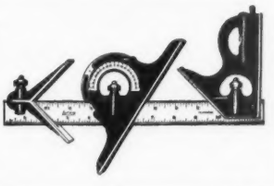

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HISTORY OF THE ARCHITECTURAL DEPARTMENT

(*Continued from page 311*)

other professions, no one of which demands more skillful, thorough, or broad training than that of architecture."

The closing years of Professor Chandler's long and most successful administration bring ample tribute to the loyalty shown by the Department's friends and graduates to the school's future interests. The annual reports tell of returning students from Europe who supply exhibitions and presents of drawings, books and photographs — Bellows, Richardson, Rebori, Williams — these and many others helped the school that had helped them. Mr. Guy Lowell is constantly referred to for generous help and interested service. In 1911 Professor Despradelle not only continued his services to our own Department but taught in similar capacity at Harvard, thus beginning that close relation between the two schools of architecture that has been carried so far to the benefit of both students and instructors during the past ten years.

Nineteen hundred and eleven was the last year of Professor Chandler's direction. To the regret of all he handed in his resignation before the opening of the new academic year, thus bringing to a close a period of twenty-three years that had been marked by constant growth and progress until the Department may well be said to have achieved the leadership among the schools in the country. This position was due to the thoroughness of the Course that was offered, to the real ability of the teachers in charge, and to the personal qualities of Professor Chandler himself. One of the Department's former students has told me how he used to linger after the close of Professor Chandler's lectures in the hope of some little talk with him personally, and so highly did he value the inspiration of this personal contact that he considers it now, as then, the most valuable feature of his entire association with the Department.

But the momentum gathered during these years of Professor Chandler's stewardship was not to be checked; it carried the school on to constant growth and accomplishment during a period when for a brief time Professor Despradelle was in charge, and when for many years Professor Lawrence acted as chairman of the Department. One loss followed closely upon another: the death of Professor Despradelle accentuated, if possible, the sense of the inestimable service that he had rendered the Department and the cause of architectural education. Two such major losses might well have been reflected by a falling off in the attendance, but such does not seem to have

(*Continued on page 338*)

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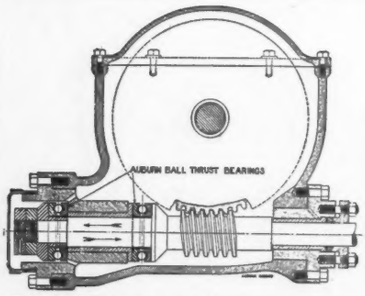

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HISTORY OF THE ARCHITECTURAL DEPARTMENT

(Continued from page 336)

been the case; increasing numbers characterize each successive report at this time and up to 1916. This includes the two years during which Mr. James Knox Taylor, former supervising architect of the Treasury, was in charge, and brings us to the devastating years of the war, and the association with Mr. Ralph Adams Cram as senior Professor of Architecture.

Closer relations with Harvard following Professor Despradelle's death, resulted from criticism in design given to our students by Professor Duquesne. During these pre-war years also a clearer differentiation was marked between the two options, landscape architecture having been dropped in 1909, and a prize was established by the Boston Society of Architects in the name of William E. Chamberlain, '77. Lack of space again becomes one of the growing Department's crying needs, for in 1916 it reached its record enrollment of one hundred sixty students in the second, third, fourth and fifth years, and opportunity for more work in the evening was sought in an effort to correct this condition.

A most generous gift of fifteen thousand dollars was made by Mrs. Harriet A. Henshaw in memory of her brother, the late Frank W. Boles, in 1916. The income of this fund is used to purchase special equipment for the design courses. To the list of significant events during this period should be added the creation by the alumni of the Department and Professor Chandler's friends of a series of prizes in recognition of his services, to be given to the best sketch-problems in the third, fourth and fifth years. At the same time mention should be made of the gold and silver medals given from 1913 to 1920 by the Société des Architectes Diplômés par le Gouvernement Français.

The Department would not now be in existence were it not for the persistent loyalty and energy of such men as Professors Lawrence, Gardner, Sumner and Brown, for the devotion of Mr. Putnam and Mr. Jenney; and it is thanks to them and that guiding master of our destinies during this trying period, President Maclaurin, that the upheaval and disintegration of these crucial years still left such a solid framework that the present Department is lifting its head to lay claim once again to the position in the profession and in the Institute that its past performance so truly merits.

No such outline of the chief events in the life of the Department of Architecture is complete without some word in appreciation of the friendly and sympathetic coöperation that the needs of the Department have almost universally received from the presidents of the Institute. This attitude, seconded as it has generally been by supporting faculty action, has enabled the Department to grow along the lines that its wise leaders have indicated. A loyal and eagerly helpful body of alumni are the best indication of the Department's appreciation for this encouragement.

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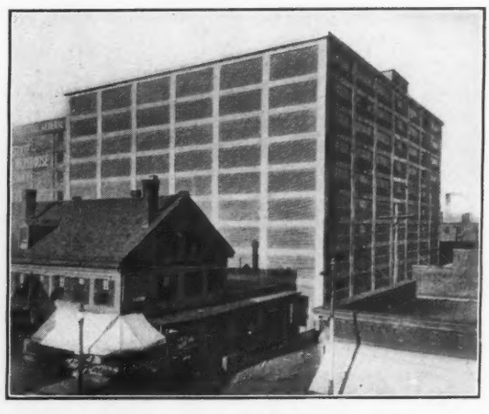

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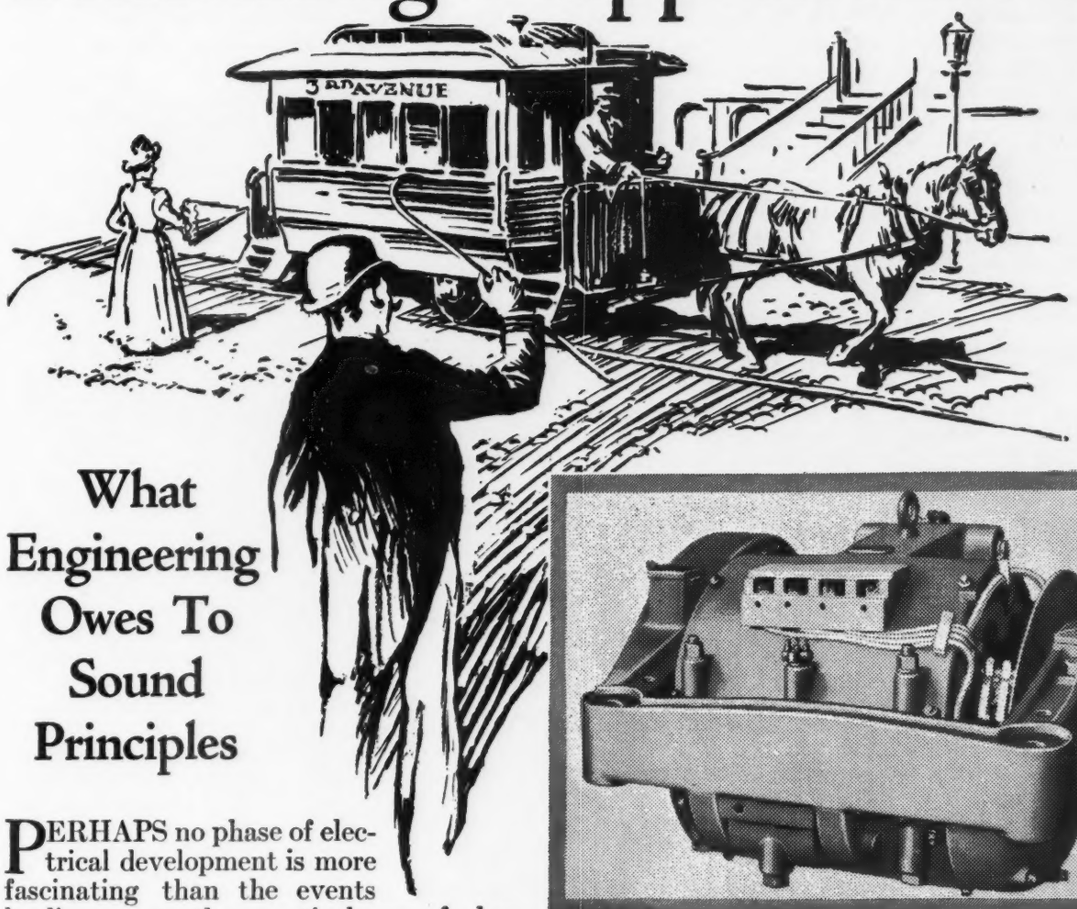
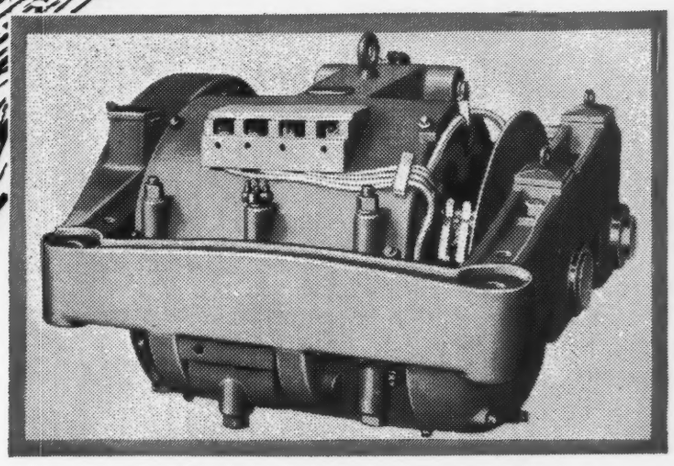


What Engineering Owes To Sound Principles



Westinghouse Motor, No. 3, the Progenitor of the Present Universally-Adopted D. C. Railway Motor.

PERHAPS no phase of electrical development is more fascinating than the events leading up to the practical use of electricity as the motive power for street railway transportation.

It is a story of "midnight oil", hard thinking, extreme perseverance. No better example of the value of sound principles to present day engineering could be cited than the Westinghouse No. 3 Motor, as introduced in 1891.

Its design was so fundamentally correct and the details were so soundly worked out that subsequent developments of railway motors all followed the principles embodied in it. Now let's see what bearing this has had on modern transportation.

In 1700 the first permanently fixed rails made their appearance. In 1831, in New York, horse cars began operation. In 1834, after fruitless attempts to apply steam, compressed air, gas, etc., to these cars, a Vermont blacksmith, one Thomas Davenport, suggested that electricity be used as the motive power.

The very first practical commercial dynamo, built by Gramme, in 1862, made this suggestion a possibility.

It was natural that George Westinghouse, with his intense interest in transportation, should take up this problem. From 1889 to 1891, he, with his organization, worked continuously to perfect a commercially practicable railway motor, and the famous No. 3, daddy of all street railway motors, was the result.

As mentioned before, the principles embodied in the No. 3, thirty-two years ago, are still in use, and at least ten prominent features of this remarkable motor are to be found in present-day types. A number of these early motors are still in operation—a tribute to sound engineering principles.

Westinghouse

WESTINGHOUSE ELECTRIC

ACHIEVEMENT & OPPORTUNITY

MOVING A BUILDING

(*Continued from page 313*)

and attached to the building and 13 of which were fixed blocks anchored to 20-foot steel rails driven about 15 feet into the ground and braced against the new concrete foundation. Twelve-inch single pulley steel blocks were used exclusively. These blocks were attached to the building or to the rail anchors with chains.

The capstans were of the single drum type, directly operated by a 4″ x 6″ hardwood sweep. The team was hitched to a point on the sweep about 10½ feet from the center of the drum and under average conditions produced a pull of about 15 lbs. on the cable for every pound of effort exerted by the team. At no time was the pull on the sweeps sufficient to cause any hardship and, it is believed, that the pull per team did not exceed 500 pounds.

Under ideal conditions the rolling friction of steel rollers laid on a perfectly level non-yielding track has been experimentally determined to be .015 or 1½% of the supported load. Such an ideal condition is never possible in the field, nor is it possible to line up several thousand rollers perfectly square with the track. Obviously, this condition will materially increase the rolling coefficient. In addition the friction load, from the pulleys, cables and capstans, must be considered and when all friction losses are summed up, will easily total up to .05 or even higher.

From calculations made, which were based on observations during moving, it is believed that the ratio between the pull of the teams and the weight of the building was about 5%.

The observed speed of the teams was two miles per hour, or about three feet per second, and the best record made was a pull of 30½″ in four minutes. The average speed of moving was four feet per hour and the total distance through which the building moved was 85 feet. The actual moving time for the entire job was 20 hours, with a maximum distance moved in one day of 42′ 3½″. In addition to being moved in a straight southerly direction, the building was turned slightly and moved 6¼″ in a westerly direction. This secondary movement of the building was accomplished by slightly skewing the rollers.

The building was landed in its final location precisely on line at all corners, the final adjustment of rollers to accomplish this end being made principally in the last 20 feet. During the latter part of the moving program accurate checks on the movement of the building were made with a transit. This served as a guide for the adjustment of the rollers and assisted materially in the general accuracy of placement.

The building was not generally occupied during actual moving operations. It was, however, necessary for certain railroad employees to enter the building from time to time and for their convenience elevator, water, light and telephone service was maintained without interruption. These facilities were in no way damaged, proving conclusively that the building was moved without appreciable settlement. In so far as the moving contractor was concerned, full occupancy of the building would have in no way affected the methods employed or the time required for moving. The vacation of the building during moving operations was a precautionary measure taken by the railroad company and undoubtedly deserves credit.

As soon as the building had been landed in its final location and all cables and tackle removed, work was commenced underpinning the building with brick work, and bringing it to rest on its new foundation. This was accomplished by building up piers between adjacent "I" beams or timbers with common brick laid in 1:2 cement mortar. These piers were keyed up against the old brickwork by means of brick wedges cut on the job and driven in drum tight with wood blocking and hammers. The same method was also used to key up the "I" beams which supported the cast-iron columns on the north and west side of the building. These beams are completely encased in the new brickwork as a safeguard against corrosion.

In order to re-establish all interior columns on the new foundation, concrete piers varying in size from 2′ x 2′ to 2′ x 3′, have been built. The "I" beam needles which supported the columns have been incorporated in the concrete and the overhanging ends cut off flush with an acetylene torch.

As an index of the amount of work involved, it will be interesting to summarize the amount of materials used: Excavation, 7,500 yards; concrete work, 1,350 yards; lumber, 600,000 feet; shingles, 1,500 bundles; cable, 13,000 linear feet; rail, 11 car loads; chain, 3,000 linear feet; pulleys, 100; Rollers, 2,000; jack screws, 1,400; structural steel, 250 tons.

In so far as it has been possible to determine, the Dowie Building is the tallest building ever moved. Its weight is about 7,500 tons. The work was done for the Illinois Central Railroad Company by William H. Brown & Company of Chicago.

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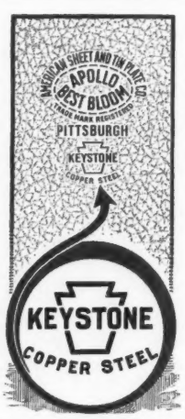

THE DISADVANTAGE OF POOR LIGHTING.

As thousands of our industrial plants are operating to-day with poor lighting and in some cases with extremely bad facilities, it would seem that the importance of the subject of lighting has not been given the serious consideration by those responsible for such conditions.

Poor lighting is one of the most serious handicaps under which a manufacturing establishment can operate. First of all, poor lighting is the cause of a large number of accidents in industrial plants; and it is singular that accident reports do not yet properly classify the hazards of poor lighting, which in many cases is the primary cause of an accident attributed to what is really a secondary cause. Safety engineers and other officials who make accident reports should always consider the condition of the lighting when working up a report of accident causes, for it plays an important part in a great many casualties and is apt to be overlooked. All accidents due to poor lighting are accidents of neglect, and are preventable. The poor lighting accident hazard is clearly chargeable to management and not men. It is a difficult matter to make such progress with Safety First in a plant which has neglected to provide one of the fundamental requirements of accident prevention—good lighting.

Probably no one single factor connected with the equipment of a plant so directly affects the efficiency and inefficiency as the quality and quantity of the lighting. The curtailment of production of all working under the disadvantage of poor lighting represents a big loss each day; the poorer the lighting the less able is the working force to function efficiently. Quality and quantity both suffer, representing a preventable loss wholly removable by improving the lighting.

Under poor lighting condition, we cannot expect and rarely do we find an orderly, clean factory. Darkened places encourage careless habits and workers are often led to deposit discarded articles or material which should be deposited elsewhere. The eyesight of those who attempt to use their eyes continually in insufficient light, below nature's demands, is often affected. Too much light, such as is furnished by bright, unprotected lights, is as harmful as too little illumination; both are fundamentally wrong. Nature's own illuminant, daylight, is unequalled for our requirements of lighting.

The eye is best suited to daylight in the proper quantity. Sun glare should be avoided, and in the darkened hours proper artificial illumination provided. Daylight should be utilized to the fullest extent. It is supplied free in abundant quantity for our use. Modern invention has supplied a means whereby the interior of buildings can be lighted by daylight, and all the advantages secured which is furnished by good lighting at the smallest cost.

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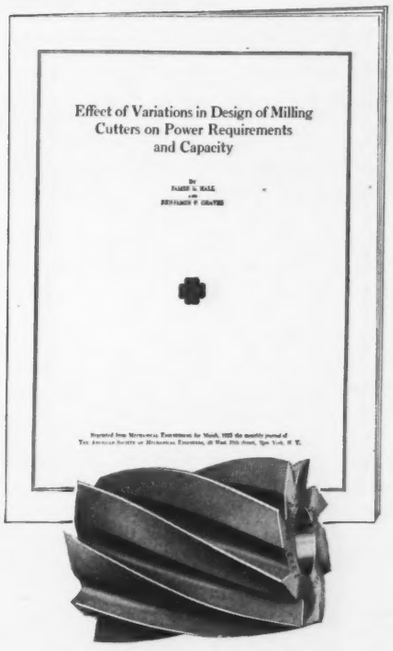

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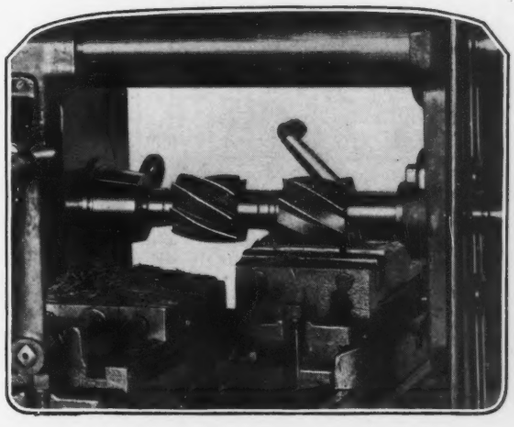

FUEL ECONOMY

(*Continued from page 317*)

the boiler which at every second of the day's run will insure the right conditions for dampers and air at the needed moment.

Fig. 1 (curves) show conditions *before* this is done and *after*. *Before* represents conditions which create a waste of fuel, bad furnace conditions with frequent necessary repairs. *After* shows the proper operating conditions where the fuel is sufficiently burned, with excellent furnace conditions. The difference between the two diagrams is due solely to elimination of guesswork in instantaneously meeting the rapid fluctuations in steam demand by the proper damper settings and air supplied to the fire. It will be noted that for best operating conditions the steam pressure may vary a total of five pounds — two and one-half pounds above and two and one-half pounds below the working pressure, which in the case of the diagram is 147½ pounds per square inch. The over fire vacuum line remains constant, while the under grate pressure varies considerably, as it should.

The method of automatic accomplishment of these perfect conditions is best shown by the diagram in Fig.2.

Two automatic controls are placed at A and B. The rise or fall of the steam pressure at A, in the steam header, acts upon a simple steam pressure controller. This regulates the position of the stack damper. When the steam pressure drops the damper opens, and when it rises the damper tends to close. As this damper proportionately opens or closes the vacuum over the fire changes. As the damper opens the vacuum increases and vice versa. This changing vacuum condition over the fire operates the simple mechanism of the furnace air controller at B, the function of which is to supply air in the right volume at the right pressure and at the right moment. Hence when the over fire vacuum increases, Controller B increases the air supply *under* the fire. When the over fire vacuum decreases the controller cuts down the air supply. In this way the over fire vacuum is held at a predetermined point and the fuel is burned at a constant rate for the steam load being produced any instant.

Imagine, for a moment, how impossible this would be for the human fireman, with guesswork as his ally, instead of exact knowledge, as with the automatic method.

This automatic damper and air regulation has in every instance saved large parts of the coal bill. In other cases it has made possible the utilization of much cheaper fuels as a source of power, while in all instances, in the case of batteries of boilers, it has reduced the number of firemen necessary.

When speaking, therefore, of "fuel economy," is it not logical that the first step should be made in the direction of providing proper regulation for the boiler in question, before proceeding further to additional means such as preheating the incoming air under the furnace or a more efficient utilization of the steam *after* it is generated? While these latter points deserve a great deal of serious consideration, with many true arguments in their favor, yet the problem boils down to the old saying of "be sure you're right, then go ahead." Be sure your boiler is right as to its ability to at least burn fuel economically from an automatic point of view, then go ahead with the added saving devices.

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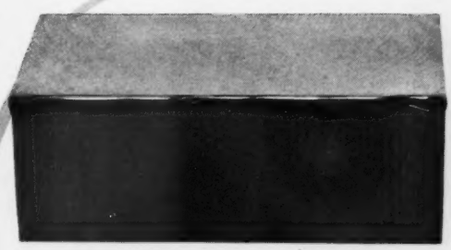
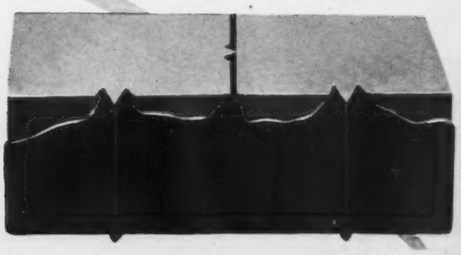
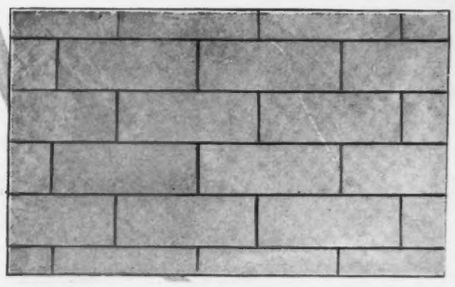


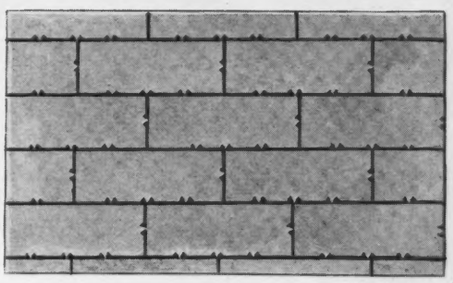
1—Showing imperfect penetration of filler with common rectangular block.



3—Showing nearly perfect penetration of filler with Kreolite Kountersunk Lug Blocks.



2—Plan view of plain or common rectangular blocks.



4—Plan view of Kreolite Kountersunk Lug Blocks.

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This method of construction permits the penetration of the bituminous filler the entire depth of the block on all sides (see figure 3) securely binding it to the base and making a firm waterproof joint. The filler (our special make) is applied hot in liquid form and hardens when cool. The block cannot become loose because it is firmly attached to the base and to the adjacent blocks on four sides. In laying, only the tough end grain is exposed to wear.

In figure 2, the blocks make a good appearance, but is another case where beauty is only skin deep. The filler solidifies and fills only the upper part of the joint (see figure 1). Note bonding power, so essential to the permanence of any block pavement, as shown in figure 4.

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To be admitted to the first year class, applicants must have attained the age of seventeen years, and must satisfactorily fulfill entrance requirements in Algebra, Plane and Solid Geometry, Trigonometry, Physics, Chemistry, English, History, and French or German and one elective subject. Examinations are required in all subjects except Chemistry, History and the elective, the requirements for which are fulfilled by the presentation of satisfactory certificates. A division of these entrance subjects between different examination periods is permitted.

Entrance examinations are held at the Institute in September. In June, applicants will be examined by the College Entrance Examination Board in Boston, New York, Philadelphia, Chicago, and many other cities in America and Europe. A circular stating times and places is issued in advance by the College Board.

Graduates of colleges and scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding to at least one year's work at the Institute, are admitted, without examination, to such advanced standing as is warranted by their previous training.

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ROGER BACON
1214-1294
English philosopher and man of science. Studied at Oxford and the University of Paris. Wrote the *Opus Majus, Opus Minus, Opus Tertium,* and many other treatises.

For this he was sent to prison

Roger Bacon may not have invented gunpowder, as has been claimed by some biographers of the famous Franciscan friar, but he exploded some of the outstanding errors of thirteenth century thought. Because of his advanced teachings, Bacon spent many years of his life in prison.

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